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2000 Annual Program Performance Report

AGRICULTURAL RESEARCH SERVICE



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FY 2000 ANNUAL PERFORMANCE REPORT

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The Agricultural Research Service (ARS) was established on November 2, 1953, pursuant to authority vested in the Secretary of Agriculture by 5 U.S.C. 301 and Reorganization Plan No. 2 of 1953, and other authorities.

ARS is the principal in-house research agency of the U.S. Department of Agriculture (USDA). Congress first authorized Federally-supported agricultural research in the Organic Act of 1862, which established what is now USDA. That statute directed the Commissioner of Agriculture "... To acquire and preserve in his Department all information he can obtain by means of books and correspondence, and by practical and scientific experiments..." The scope of USDA's agricultural research programs has been expanded and extended more than 60 times in the 139 years since the Department was created.

The research currently performed by ARS is authorized by the Department of Agriculture Organic Act of 1862 (7 U.S.C. 2201 note), Agricultural Research Act of 1935 (7 U.S.C. 427), Research and Marketing Act of 1946 (P.L. 79-733), as amended (7 U.S.C. 427, 1621 note), Food and Agriculture Act of 1977 (P.L. 95-113), as amended (7 U.S.C. 1281 note), Food Security Act of 1985 (P.L. 99-198) (7 U.S.C. 3101 note), Food, Agriculture, Conservation, and Trade Act of 1990 (P.L. 101-624) (7 U.S.C. 1421 note), Federal Agriculture Improvement and Reform Act of 1996 (P.L. 104-127), and Agricultural Research, Extension, and Education Reform Act of 1998 (P.L. 105-185). ARS derived most of its objectives from statutory language, specifically the "Purposes of Agricultural Research, Extension, and Education" set forth in Section 801 of FAIR.

The ARS mission is to conduct research to develop and transfer solutions to agricultural problems of high national priority and provide information access and dissemination to: ensure high-quality, safe food, and other agricultural products; assess the nutritional needs of Americans; sustain a competitive agricultural economy; enhance the natural resource base and the environment; and provide economic opportunities for rural citizens, communities, and society as a whole.

Verification, Validation, and Program Evaluation: ARS currently conducts a series of review processes designed to ensure the relevance and quality of its research work and maintain the highest possible standards for its scientists. This process involves customer input to help keep the research focused on the technical needs of the American food and agricultural system. Each of the approximately 1,100 research projects, which are organized into 22 National Programs, undergoes a thorough merit review before new or renewed activities are begun. All ARS employees, including the scientific workforce, are subject to annual performance reviews, and the senior scientists undergo a rigorous peer review (Research Position Evaluation System—RPES) on a 3- to 5-year cycle. These processes ensure the continuing high quality of the ARS scientific workforce.

The new National Programs focus the work of the Agency on achieving the goals defined in the ARS Strategic Plan. The research priorities for each National Program are established with extensive input from customers, stakeholders, and partners received, in part, at a series of National Program Workshops. A detailed Action Plan is developed for each National Program and it is available on the ARS home page – www.ars.usda.gov. In FY 2000, ARS began a series of National Program and program component reviews that help to ensure the quality, relevancy, effectiveness, and productivity of the work being done in each National Program. Additional information on the new ARS quality review program is available on the ARS home page – under "Scientific Quality Review." The Annual Performance Plans will also serve to keep the work of the Agency focused on achieving the goals established in the ARS Strategic Plan. The aggregate effect of these changes will be a strengthened research program and an accountability system that will measure more effectively the progress made towards achieving established goals and outcomes.

Additional information describing the key external factors affecting the ability of ARS to achieve the goals and objectives described in this report and a description of the Agency's partnerships with other Federal agencies can be found in the introduction of the ARS Annual Performance Plan. The Annual Performance Plans and

Reports are also available on the ARS home page.

In FY 2000, ARS reviewed its Strategic Plan as required by GPRA. Since a transition was approaching from one Presidential Administration to the next, the decision was made to refine and update the existing Strategic Plan (1997-2002) rather than completely revise it. However, several years of experience with GPRA led us to make substantial changes in two parts of the Plan - Administrative, Programmatic, and Management: Initiative 2 (National Agricultural Library) and Initiative 3 (Creative Leadership). The Annual Performance Report for FY 2000 contains the "old" language from last year's Annual Performance Plan, but the Accomplishments and Impacts/Outcomes have been reported against the new and more relevant indicators contained in Appendix A. Next year, Appendix A will be fully integrated into both the Annual Performance Plan for FY 2002-2003 and the Annual Performance Report for FY 2001.

In January 1998, ARS requested permission from the Office of Management and Budget (OMB) "to describe specific and tangible products, steps, intermediate goals, and/or accomplishments that will demonstrate that the Agency has successfully met each Performance Measure/Goal in a given fiscal year." With OMB's concurrence, ARS has employed narrative descriptions of intermediate outcomes and indicators of progress instead of numerical metrics. The indicators listed in this Annual Performance Report represent intermediate outcomes, significant research accomplishments, and actual or anticipated impacts/outcomes of the Agency's work, which serve to measure progress during FY 2000. The research and technology transfer activities listed in this report are not all inclusive of the Agency's work. The indicators reflect, but do not adequately capture the broad range of basic research that underpins much of the Agency's work. Because of the unique nature of research, as recognized by the OMB waiver, ARS accomplishments are described using a nonnumeric narrative approach that may differ from the style and format used by most other USDA Agencies.

Only Federal employees were involved in the preparation of this report.

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GOAL I: Through Research and Education, Empower the Agricultural System with Knowledge That Will Improve Competitiveness in Domestic Production, Processing, and Marketing.

Analysis of Results: This goal is the focus of much of ARS' research related to production agriculture. Under Goal I, 70 Indicators are aligned under 12 Performance Goals. Because of the unique and dynamic nature of research, several Indicators were added or modified in this Report that did not first appear in the Annual Performance Plan for FY 2000. This was done to ensure that significant accomplishments that were not anticipated last year were reported. While it is not possible to report research accomplishments numerically, the progress projected in all 62 Indicators was completed or substantially completed during FY 2000.

OBJECTIVE 1.1: Strengthen Competitiveness: "Enhance the competitiveness of the U.S. agriculture and food industry in an increasingly competitive world environment."

STRATEGY 1.1.1: Cost-effective agricultural production systems: Develop new knowledge and integrated technologies for more efficient and economically sustainable agricultural production systems of all sizes.

PERFORMANCE GOAL 1.1.1.1: Demonstrate and transfer to users integrated systems.

Indicators:

During FY 2000, ARS will incorporate into the "Decision Evaluator for the Cattle Industry (DECI)" model for use by cattlemen, new strategies and management systems to reduce feed costs for brood cows and to raise replacement heifers more economically.

ACCOMPLISHMENTS: A forage growth model was integrated into the Decision Evaluator for the Cattle Industry (DECI) and evaluated for predicting animal performance under different forage growth conditions. Natural grasslands are a valuable food resource for cattle, but producers need to utilize this resource in a sustainable manner.

IMPACT/OUTCOME: This combined DECI model provides a valuable tool to evaluate different strategies for utilizing natural and improved grasslands.

PERFORMANCE GOAL 1.1.1.2: Demonstrate and transfer to users computer-based simulation models and decision support systems.

Indicators:

During FY 2000, ARS will continue beta tests with both the new generation cotton model and GPFARM.

ACCOMPLISHMENTS: Beta tests were continued for both models. The new generation cotton model received its first full year of broad testing across the U.S. Cotton Belt, with involvement of both ARS and State Experiment Station and State Cooperative Extension Service personnel. Tests were restricted to experimental farms. GPFARM beta testing was continued and was extended to 20 operating farms and ranches of Eastern Colorado.

IMPACT/OUTCOME: Based on results of the beta tests, both models were substantially improved.

ACCOMPLISHMENTS: Validation tests of the new cotton model were suspended for 2000 because of a lack of funding. Tests from the previous year indicated considerable promise for the model to perform well as a decision-aid model across the entire Cotton Belt. Discussions are underway about the future of the model.

IMPACT/OUTCOME: The model retains much value as a potential link between precision agriculture and prescriptive farming (i.e., after soil variability is mapped, what does one do to manage the crop?). This model is capable of making those determinations, and will find use in this application when it is fully validated.

STRATEGY 1.1.2: Postharvest control of pests: Develop postharvest technologies and processes to meet domestic needs and reduce or overcome nontariff trade and quarantine barriers caused by pests (insects, weeds, pathogens, etc.).

PERFORMANCE GOAL 1.1.2.1: Demonstrate techniques to control or eliminate postharvest insects and diseases, and increase market quality and product longevity.

Indicators:

During FY 2000, ARS will

continue efforts to understand insect resistance in corn varieties and use the information to develop new alternative pest control methodologies.

ACCOMPLISHMENTS: Avidin is a protein found in chicken egg white that is toxic to insect pests that attack grain. Scientists in the Biological Research Unit (BRU) of Grain Marketing and Production Research Center (GMPRC) in Manhattan, Kansas, and at Kansas State University have incorporated the gene that codes for avidin into corn. Avidin acts by binding to the vitamin, biotin, and making it unavailable to the insects. Levels that were toxic to insects showed no apparent oral toxicity to mice. Avidin has potential for controlling both field and post-harvest insect pests of cereals and the processed commodities made from cereals. In addition, BRU scientists have found a protein in potato that selectively inhibits a key component of the digestive system of corn rootworms. Incorporation of the gene into agriculturally important plants may protect them from insect pest attack.

IMPACT/OUTCOME: Dr. Karl Kramer (USDA-ARS-GMPRC Biological Research Unit in Manhattan, Kansas) and others received a U.S. Patent (S/N 08/524,051) entitled "Recombinant Chitinase and Use Thereof as a Biocide." Chitinase is an enzyme that degrades the polysaccharide, chitin, found in the guts and exoskeletons of insects and cell walls of fungi. Several crops are being genetically engineered to express a protein encoded by an insect chitinase gene in order to provide resistance to insects and fungal diseases. Biopesticides are very promising tools for the control of insect pests in grain during both production and storage that are just beginning to be developed. They are environmentally friendly and highly cost effective.

continue cooperative efforts in the development of environmentally friendly and generally nontoxic biopesticides and natural product based pesticides.

ACCOMPLISHMENTS: Scientists at the ARS Grain Marketing and Production Research Center in Manhattan, Kansas, were the first to report that avidin, a common egg protein, had insecticidal activities against beetles and moths that attack corn, wheat, rice, and other grains. Together with a biotech company, they demonstrated that cornmeal made from corn that produced avidin was resistant to insect attack.

IMPACT/OUTCOME: Corn containing avidin would have longer shelf life and require no insecticidal treatments reducing risks to human health and the environment. Farmers would benefit from the higher prices that improved quality corn would command.

ACCOMPLISHMENTS: The insecticide, doramectin, was evaluated for efficacy in controlling horn flies and ticks feeding on cattle and on horn flies developing in the manure. Oral dosing with doramectin controlled horn flies feeding on blood and immature horn flies developing in the manure of treated cattle. In addition, doramectin provided 100 percent protection against feeding by Lone Star ticks. Delivery of the insecticide in a mineral block proved to be an effective method.

IMPACT/OUTCOME: Use of doramectin in mineral blocks is an effective way for ranchers to improve animal productivity by minimizing losses due to ectoparasites such as horn flies and ticks. This technology is being evaluated for commercial development by major animal health companies.

continue the evaluation of resistance genes and begin the establishment of molecular markers in order to accelerate the incorporation of this resistance into commercial varieties.

ACCOMPLISHMENTS: After a series of National Program Workshops, ARS revised some of its research activities to focus on areas of higher priority. Research activities under this Performance Indicator were redirected into other areas.

continue development of alternative insect pest control methodologies. Specific protection methodologies will be tested in an areawide IPM Program involving producers, grain elevator operators, and wheat mills in Kansas and Oklahoma.

ACCOMPLISHMENTS: ARS scientists in Manhattan, Kansas, and state researchers have gathered scientific data that grain elevator managers can use to thwart damage caused in stored wheat by the lesser grain borer, rice weevil, red flour beetle, and rusty grain beetle. Since the summer of 1998, Federal and State scientists in an areawide IPM effort have been monitoring insect levels and current pest management practices at 13 elevators in Kansas and 15 in Oklahoma. This is a collaborative study between major grain handling companies, Kansas State University, Oklahoma State University, and ARS. The work focuses on day-to-day elevator management practices - how these practices affect the cost and effectiveness of insect control and impact the economics of moving and storing grain. The scientists have identified three main ways to improve integrated pest management in grain elevators: (1) cooling the grain earlier in the storage season, particularly right after it enters the bin; (2) cleaning empty bins more thoroughly; and (3) fumigating wheat only when insect infestations reach unacceptable levels.

IMPACT/OUTCOME: The Kansas-Oklahoma areawide project is one of several ARS programs developed in response to USDA's Integrated Pest Management Initiative. As a result of the project, by 2002 researchers will have developed an integrated pest management program for wheat stored at elevators. Research data collected during the areawide IPM study substantiate that the recommendations to improve IPM in stored grain is cost-effective. Stored grain insects cost the U.S. wheat industry about \$500 million annually thus, using the recommended tactics offered by the project would result in a considerable savings .

ACCOMPLISHMENTS: Reducing the use of pesticides to control household insects requires increased knowledge of when and where to apply treatments that will produce the most effective results. A spatially-based system for monitoring insect pest distributions and precision targeting of treatment was developed. Customized programming, coupled with Geographic Information Systems (GIS) software provided a simple process of entering spatially-referenced data, determining pest distributions, identifying areas for treatment, documenting the amount of pesticide used and the reductions in pest populations. The use of this precision targeting system has been documented in retail stores and hospitals.

IMPACT/OUTCOME: The value of this research was recognized by EPA, DoD, and DoE with a Pollution Prevention Project of the Year Award. The software was delivered to DoD, Armed Forces Pest Management Board, and is in use by the U.S. Army for tick control, turf insect management, weed management, and fire ant management. The Navy uses this system for control of pests on aircraft carriers. The software is available to the public through the ARS website and is being used by three commercial pest control companies.

evaluate various commodity treatments for control of postharvest decay of citrus, apples, potatoes, and other crops.

ACCOMPLISHMENTS: After a series of National Program Workshops, ARS revised some of its research activities to focus on areas of higher priority. Research activities under this Performance Indicator were redirected into other areas.

determine the tolerance of various major varieties of tangerines/hybrids and round orange citrus types marketed as fresh fruits treated with low dose irradiation and conduct preliminary investigations to determine the response of methyl jasmonate for reducing peel injury to grapefruit due to irradiation exposure.

ACCOMPLISHMENTS: This project was not initiated due to the retirement of the responsible scientist whose position was not subsequently filled.

study the effects of heat/long-term controlled atmosphere quarantine treatment of pears and apples on fruit quality. Complete the insect mortality efficacy testing of this treatment to assure that it provides adequate quarantine security for U.S. trading partners.

ACCOMPLISHMENTS: ARS scientists at Wenatchee and Yakima, Washington, determined that fruits increased in firmness and in soluble solids/tritratable acidity ratios after treatment. This treatment also suppressed storage scald and decay. Efficacy tests were conducted against the codling moth, apple maggot, and plum curculio. A 4-hour treatment at 44 degrees C, followed by CA-cold storage, resulted in complete mortality of these pests.

IMPACT/OUTCOME: The treatment provided good quality fruit with higher firmness and sweeter taste than untreated fruit. This assures that quality will not be compromised in the development of new quarantine treatments and provides an alternative to conventional methods.

PERFORMANCE GOAL 1.1.2.2: Demonstrate technologies to control quarantine pests.
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Indicators:

During FY 2000, ARS will

expose commodities to new fumigants at various concentrations to determine their potential as alternatives to methyl bromide. Fruit and nuts will be infested with an appropriate postharvest insect pest, treated, and evaluated as to efficacy and phytotoxicity.

ACCOMPLISHMENTS: Scientists at the ARS laboratory in Fresno have identified several fumigants that have potential as replacements for methyl bromide. Of these, sulfuryl fluoride used at very low doses and short treatment times was very effective against navel orangeworm, Amyelois transitella, and diapausing larvae of the codling moth, Cydia pomonella.

IMPACT/OUTCOME: These results show that sulfuryl fluoride is a suitable replacement for the existing methyl bromide quarantine treatment presently used on export walnuts destined for the European Union (EU). The treatment could be implemented without additional capital investment. Its use would maintain the U.S. walnut export market in the EU that will otherwise be jeopardized with the loss of methyl bromide.

investigate different sorption substrates for their ability to trap methyl bromide in an effluent gas stream. Those considered promising will be further investigated to determine their ability to sorb and desorb methyl bromide under various temperature and relative humidity conditions.

ACCOMPLISHMENTS: Scientists at the ARS laboratory in Fresno have looked at several substrates for adsorbing methyl bromide from an airstream and found that activated carbon is the most sorbent material and that activated carbon derived from coconut shells is superior to activated carbon obtained from peat or petroleum. The moisture content of the airstream had only a minor effect on the amount of methyl bromide

that could be sorbed onto a given amount of activated carbon.

IMPACT/OUTCOME: These results are valuable because they verify that experiments conducted under a CRADA at the Fresno lab to develop a working system to sorb methyl bromide were conducted on the most efficient substrate tested for that purpose. The results of this testing also validate the building of working commercial units at the Dallas/Ft. Worth International Airport and by a major strawberry shipper in Watsonville, California.

test the new Mediterranean fruit fly attacking strain of parasite, B. arisanus in field cage evaluations in Guatemala and Mexico in preparation to transferring the parasite to APHIS for use in those countries. Assistance will be provided to APHIS for developing colonization and mass rearing procedures.

ACCOMPLISHMENTS: Scientists at the ARS Pacific Basin Agricultural Research Center developed an improved strain of the Mediterranean fruit fly (Medfly) egg parasite *F. arisanus*. Field surveys of coffee fields in Hawaii indicated that this parasite was the most abundant natural enemy of the pest in coffee and field tests and confirmed that it was capable of suppressing Medfly populations.

IMPACT/OUTCOME: ARS transferred the laboratory-adapted strain of *F. arisanus* to APHIS and it now has it in culture in Guatemala. The parasite will be available for release there to suppress Medfly and other fruit fly species as part of the program to protect U.S. agriculture from Medfly arriving in the U.S. from Central America.

PERFORMANCE GOAL 1.1.2.3: New and improved diagnostic tests are developed and available.

Indicators:

During FY 2000, ARS will

continue the investigation of near infrared (NIR) as a tool for mosquito analysis. The species determination capabilities of the instrument will be verified and its ability to detect the presence of malarial organisms within the mosquito will be evaluated. Such information will provide the first rapid mosquito analytical method available, and save millions of dollars in time and effort worldwide.

ACCOMPLISHMENTS: This technique has proven useful for age-grading and identifying species of mosquitoes that carry malaria. However, the technique cannot determine if individual mosquitoes are carrying the malarial organisms. The technique has also been shown to differentiate species of stored grain insects, parasitoids, and to age-grade flies.

IMPACT/OUTCOME: This simple, rapid, and nondestructive technique provides a means to rapidly determine the species and age of pest insects. This information can then be used to implement appropriate control or quarantine strategies.

evaluate the potential of the semi-automated microplate assay, blot assay, and other assays that can be used to detect and monitor pesticide resistance in insects.

ACCOMPLISHMENTS: Scientists at the Grain Marketing and Production Research Center have identified strains of lesser grain borer, a destructive pest of grain, that shows extreme resistance to the fumigant phosphine, and they have developed strategies to isolate the genes responsible for this resistance. The cytochrome C oxidase gene known to be involved in phosphine resistance has been cloned, a necessary step in developing quick molecular assays for resistance.

IMPACT/OUTCOME: Phosphine is the primary tool for control of stored-grain insects but insect to it is an emerging threat in stored product insect pest protection. The lesser grain borer has recently spread

northward, becoming a severe pest of stored grain in previously uninfested areas. This research will result in identification of DNA markers that can be assayed in a high-throughput microplate platform for rapid detection of resistance using dead insects or even insect parts which will provide the grain industry with much needed technology to manage the pest problem.

cooperate with the grain industry in Kansas and Oklahoma in using detection technology for monitoring the level of insect infestation in wheat to improve quality through the application of a variety of insect control measures.

ACCOMPLISHMENTS: Scientists at the ARS Grain Marketing and Production Research Center conducted research to measure the movement of stored-product insect pests in and around food processing and storage facilities. Using a two-part program consisting of (1) a grid of pheromone traps and contour mapping to visualize insect distribution and (2) pheromone stations that mark and release insects that can then be recaptured in other locations, the researchers were able to successfully identify major sources of insects at a pet food manufacturing plant.

IMPACT/OUTCOME: Sanitation efforts targeted at the major pest source have reduced insect density in other areas of the facility and reduced the potential for product infestation and the need for chemical intervention. This technology has broad application to a variety of food and feed manufacturing and processing plants throughout the country.

begin studies to determine the influence of insect movement behavior and response to pheromones on the implementation and interpretation of pest insect monitoring programs.

ACCOMPLISHMENTS: In a cooperative research program with industry, ARS scientists at the Grain Marketing and Production Research Center, Manhattan, Kansas, initiated experiments to measure the movement behavior of stored-product insect pests in and around food processing and storage facilities. A two part program was developed that uses (1) a grid of pheromone traps and contour mapping to visualize insect distribution and (2) pheromone stations that mark and release insects that can then be recaptured in other locations to determine the distance and direction of pest movement.

IMPACT/OUTCOME: This approach was used to identify a major source of insects at a pet food manufacturing plant. Pheromone trap catches indicated areas of high insect density and recapture of marked insects indicated which area was a major source of insects in other parts of the facility. Sanitation efforts targeted at this major pest source have reduced insect density in other regions of the facility and have reduced the potential for product infestation and the need for chemical intervention.

determine the optimal density of McPhail traps or others for detecting or delimiting Mexican fruit fly outbreaks. This will be accomplished by conducting research to test the effective distance at which an adult fly would be at risk of capture by a McPhail trap.

ACCOMPLISHMENTS: Experiments were run in citrus orchards and on native host plants in mountainous areas to test trap distribution, fly dispersal, and effects of habitat on Mexican fruit fly capture in McPhail traps from native and released sterile populations. Habitat and weather were identified as key factors affecting fly dispersal and optimal trap distribution.

IMPACT/OUTCOME: Logistics and the economics of trapping systems suggest that the current system of placing traps in host trees in most areas of south Texas is the best strategy rather than concentrating on trap distribution distances.

develop and test a long lasting lure containing a new synthetic attractant for efficacy in citrus orchards. Bait stations will continue to be improved and tested with emphasis on the Mexican and Mediterranean fruit fly.

ACCOMPLISHMENTS: A gelled toxic bait suitable for use in bait stations was developed, tested for periods

up to 5 months, and found to be equal or better than torula yeast bait that must be replaced weekly.

IMPACT/OUTCOME: A commercial company in South Carolina has designed a cheap, hinged station that can be stacked into compact units, which is currently in production for experiments. This station is light enough so a field worker can carry up to 100 stations. The bait is packaged in a modified foil covered plastic cup (similar to those used for condiments and jellies) that snaps into the station.

transfer to APHIS recombinant antigen-based diagnostic tests for equine piroplasmosis.

ACCOMPLISHMENTS: ARS scientists in Pullman, WA, developed recombinant antigen based diagnostic tests for hemoparasites (U.S. Patents #5,798,219 & #5,643,737) including tests for anaplasmosis caused by *Anaplasma marginale*, an ehrlichial pathogen of cattle, sheep and goats and equine babesiosis caused by *Babesia equi* and *Babesia caballi*. These tests have been transferred to industry and to NVSL-APHIS in the case of equine babesiosis. USDA approval of the anaplasmosis diagnostic test is expected early in 2001.

IMPACT/OUTCOME: The development of the anaplasmosis test enabled Canadian scientists to identify the disease in their country and to determine its epidemiology. Prior to the availability of this test, Canada was thought to be anaplasmosis-free, preventing export of U.S. cattle carrying anaplasmosis to Canada. A collaborative project with APHIS is planned to determine the epidemiology of anaplasmosis in the U.S. Similar collaborative projects are being established to test the true status of equine babesiosis in the Southern U.S.

validation of a live animal test for scrapie in sheep.

ACCOMPLISHMENTS: ARS scientists at Pullman, Washington, developed the first practical live animal test for scrapie and the techniques for identifying pre-clinically infected sheep over the age of 18 months at slaughter. This technique uses a biopsy from the third eyelid and detects an abnormal prion protein by immunohistochemical methods. This technique has been transferred to USDA-APHIS-VS and the antibodies made commercially available. Through collaborative research with the National Animal Disease Center (Ames, IA), Washington State University (Pullman, WA), APHIS, MAFF (United Kingdom) and Utah State University (Logan, UT), ARS scientists published stage 2 OIE (Office of International Epizootics) validation of the third eyelid test. A collaborative project has been developed with APHIS to complete stage 3 OIE validation of this test.

IMPACT/OUTCOME: The third eyelid test is the first practical and reliable live animal test for pre-clinical diagnosis of scrapie. This test will be crucial for epidemiological screening of infected herds worldwide and will provide significant protection to the U.S. sheep industry.

develop methods for rapidly identifying avian influenza viruses and infections by different avian influenza virus strains.

ACCOMPLISHMENTS: ARS scientists at Athens, Georgia, are establishing a DNA sequence database for various subtypes of avian influenza virus and developing molecular methods using heteroduplex mobility assay to quickly identify the subtypes of avian influenza virus.

IMPACT/OUTCOME: The heteroduplex mobility assay will allow quick identification of influenza isolates in real time when an outbreak occurs as opposed to the slower method of DNA sequence identification. It will also allow better understanding of the biological and molecular events that result in a shift in virulence among avian influenza strains and provide a sensitive method to compare unknown isolates to a reference standard. This assay will allow rapid and cost-effective large-scale screening of many different influenza viruses and provide crucial information on the epidemiology of emergent virus strains for the U.S. poultry industry.

STRATEGY 1.1.3: Measurement of product quality and marketability: Improve quality, uniformity, value, and marketability of commodities and other agricultural products.

PERFORMANCE GOAL 1.1.3.1: Demonstrate postharvest technologies that add value and improve quality.

Indicators:

During FY 2000, ARS will

transfer a food product database to users for measuring total dietary fiber in foods.

ACCOMPLISHMENTS: Preliminary data has been accumulated, in cooperation with the USDA Food Safety Inspection Service Eastern Laboratory, on the rapid prediction of total dietary fiber by near-infrared reflectance spectroscopy in dried, de-fatted frozen and shelf-stable meals. Results indicate the feasibility of a spectroscopic approach to this problem. In addition, sampling strategy has been developed for the collection of near-infrared spectra from fresh homogenized samples. Continuation of the project is awaiting the results of an FSIS committee on establishing priorities for ARS/FSIS collaborative projects.

IMPACT/OUTCOME: The development of a successful spectroscopic method to analyze dietary fiber in fresh, homogenized, microwavable meals would decrease the time required for analysis of dietary fiber, by the FSIS and food industry laboratories, from 5 days to approximately 30 minutes.

scale up the enzymatic retting process for commercial development using fiber flax and seed flax straw to produce high and consistent staple length flax/linen fibers tailored for use by specific industries.

ACCOMPLISHMENTS: A building at the USDA-ARS Cotton Quality Research Station, Clemson, South Carolina, was identified for a pilot-plant cleaning system. An agreement was signed with the Department of Agricultural and Biological Engineering, Clemson University, to develop the system based on existing designs. Development of the system is underway.

IMPACT/OUTCOME: The U.S. is the biggest user of linen (derived from flax) in the world, but all of the fiber is imported. As a first step in developing a domestic flax industry, this research is establishing procedures to generate a clean, uniform, reliable product.

continue to update the information in the Stored Grain Advisor software and expand coverage to include corn in addition to wheat. A new version of the software will also be developed that is more applicable to storage conditions and problems found in large concrete grain elevators.

ACCOMPLISHMENTS: A new version of the Stored Grain Advisor (SGA) called SGA Pro was developed for use by commercial grain storage managers. The users select weather data files for their locations and inputs information about bin size, bin wall material, types of grain, aeration fan size, types of aeration controllers, initial grain temperature and moisture, storage data, and expected ship date. SGA Pro can predict insect densities for five species of stored grain pests, as well as the number of insect damaged kernels to expect with time. It also predicts the effects on insect populations of various control methods such as treatment with phosphine, controlled atmospheres, aeration, and various insecticides. The economic consequences of various management options are also provided to the user.

IMPACT/OUTCOME: SGA Pro is being field tested as a key component of the areawide integrated pest management project that is being conducted in grain elevators located in Kansas and Oklahoma. This project applies a systems approach to manage grain quality as it moves from the farm to various markets. If proven successful in this field trial, the SGA Pro will be offered to grain handlers nationwide to serve as a cost effective tool for controlling insect pests and improving the quality of U.S. grain.

continue to cooperate with various industry partners to develop more effective insect controls and provide information linking the insect trap catch data to the economic impact of specific levels of infestation.

ACCOMPLISHMENTS: In cooperation with insect trap manufacturers, scientists at the ARS Grain Marketing and Production Research Center developed pheromone-baited traps to monitor insect activity in food processing facilities, warehouses and retail outlets. These nontoxic traps allow the user to locate low level insect infestations before they reach intolerable levels and provide users with nonchemical alternatives for control at reduced costs.

IMPACT/OUTCOME: The use of pheromone-baited traps has become an important component of integrated pest management systems (IPM) and can reduce the dependence and costs associated with insecticide treatments. Product quality has been maintained both domestic and export markets as a result of this technology.

evaluate the application of specific insect monitoring, control, and sanitation programs at each of the areawide stored wheat IPM program test sites and evaluate the impact on wheat quality and insect populations.

ACCOMPLISHMENTS: ARS scientists in Manhattan, Kansas, and state researchers have gathered scientific data that grain elevator managers can use to thwart damage caused in stored wheat by the lesser grain borer, rice weevil, red flour beetle, and rusty grain beetle. Since the summer of 1998, Federal and State scientists in an areawide IPM effort have been monitoring insect levels and current pest management practices at 13 elevators in Kansas and 15 in Oklahoma. This is a collaborative study between major grain handling companies, Kansas State University, Oklahoma State University, and ARS. The work focuses on day-to-day elevator management practices - how these practices affect the cost and effectiveness of insect control and how they impact the costs of moving and storing grain. The scientists have identified three main ways to improve integrated pest management in grain elevators: (1) cooling the grain earlier in the storage season, particularly right after it enters the bin; (2) cleaning empty bins more thoroughly; and (3) fumigating wheat only when insect infestations reach unacceptable levels.

IMPACT/OUTCOME: The Kansas-Oklahoma areawide project is one of several ARS programs developed in response to USDA's Integrated Pest Management Initiative. As a result of the project, researchers by 2002 will have developed an integrated pest management program for wheat stored in elevators. Research data collected during the areawide IPM study substantiate that the recommendations to improve IPM in stored grain is cost-effective. The stored grain insects involved cost the U.S. wheat industry about \$500 million annually thus, using the recommended tactics offered by the project would result in considerable savings .

continue the development of the wheat end-use quality relational database.

ACCOMPLISHMENTS: Using a simple, user-friendly relational database system developed by ARS, we summarize and interpret end-use quality data of hard winter wheat breeding lines can be summarized and interpreted.

IMPACT/OUTCOME: The database system provides simultaneous assessment of multiple quality traits on a standardized scale; user specified prioritization of end-use quality traits for numerical and qualitative ratings of genotypes; tabulation of major quality deficiencies of genotypes and summarization of quality ratings for a genotype across multiple nurseries. Food manufacturers and other customers can use the information in this database to determine which varieties possess the necessary quality traits needed for making each of the products that they produce.

conduct grain drying tests to determine the energy performance of an experimental closed-loop heat pump grain dryer in cooperation with a CRADA partner and the Department of Energy. Energy performance was found to be three to four times greater than conventional high temperature batch dryers and 15 to 20 percent higher than that reported in the literature for heat pump-based grain drying, but management, automation and control of grain flow, air flow, and refrigerant flow needs improvement to sustain total system performance.

ACCOMPLISHMENTS: No further progress was made on this topic beyond the accomplishments reported

last year. The project has been terminated.

evaluate the potential for development or installation of online sensing devices in a pilot elevator for automatic quality segregation of incoming grain.

ACCOMPLISHMENTS: No progress to report on this topic.

cooperate with grain cleaner manufacturers and Kansas State University research associates in reviewing the engineering design requirements for removing dockage from wheat in high capacity systems at grain export facilities.

ACCOMPLISHMENTS: No progress to report. Project was terminated.

evaluate strong and weak gluten wheat flours for frozen dough quality through fractionation and reconstitution of the major flour components, and ascertain which component causes dough weakening during proofing and baking.

ACCOMPLISHMENTS: Found that flour components from strong gluten wheats were found to have a highly positive effect on frozen dough quality, whereas weak gluten wheats had a negative effect. This demonstrated that glutenin plays a predominant role in frozen dough quality.

IMPACT/OUTCOME: Information will provide the basis for improving quality of frozen dough.

continue to refine the enzymatic "retting" process to separate flax fibers from the stem of the flax plant. ARS will provide the capability to "cottonize" the fiber, i.e., to cut it into staple lengths so that it can be processed on cotton equipment, and begin studies on the utilization of this material for cotton-linen blends.

ACCOMPLISHMENTS: New commercial enzymes and low-cost chelating agents were evaluated for effectiveness at retting. A color test method for proposed industry color standards has been written and is being considered by ASTM (American Society for Testing Materials). Fabrics with specific blend levels of cotton and flax fiber were evaluated cooperatively with the University of Georgia, to establish specific properties with the blending of flax into the cotton.

IMPACT/OUTCOME: The U.S. is the biggest user of linen (derived from flax) in the world, but the fiber is all imported. As a second step in developing a domestic flax industry, this research is establishing standards of quality against which the quality of the product can be judged, and pricing determined.

PERFORMANCE GOAL 1.1.3.2: Provide knowledge and technology to expand and improve the grading systems for agricultural commodities and products.

Indicators:

During FY 2000, ARS will

implement a new "end-use" classification and measurement scheme to be used intermittently for wheat.

ACCOMPLISHMENTS: The Kansas Wheat Commission asked ARS to develop simple, rapid, safe, and objective procedures for determining red and white wheat color class. Scientists and engineers at Manhattan, Kansas, optimized procedures that involve soaking kernels in sodium hydroxide, resulting in a rapid change in seed color that makes color classification simple and accurate.

IMPACT/OUTCOME: This color classification test is now commercially marketed and used by the wheat industry and inspectors to determine wheat color class. This simple procedure can help promote the adoption

and segregation of white wheat and help expand export markets for U.S. white wheat.

continue working with the grain industry to establish an acceptable standard for red versus white classes of wheat. In addition, ARS will test the effectiveness of a modified instrument to predict the end-use performance of wheat samples and analyze important properties of other small grains, such as sorghum, rice, and oats.

ACCOMPLISHMENTS: Developed optimized procedures that makes color classification simple and accurate. This color classification test is now commercially marketed and used by the wheat industry and inspectors to determine wheat color class.

IMPACT/OUTCOME: This simple procedure can help promote the adoption and segregation of white wheat and help expand U.S. white wheat export markets.

provide the Grain Inspection, Packers, and Stockyards Administration (GIPSA) with an experimental automatic test weight prototype and specifications for use in developing an evaluation site for automated grain inspection data collection.

ACCOMPLISHMENTS: No progress to report. Project terminated.

continue cooperation with Perten Instruments of North America to add NIR measurements of wheat to the Perten 4100 Single Kernel Characterization System (SKCS). This instrument, which will be commercially available, objectively distinguishes red and white kernels of wheat and measures the protein concentration in single wheat kernels. The NIR instrumentation can also detect the presence of internal insects in single kernels and bunted kernels in addition to providing standard SKCS measures of single wheat kernel hardness, weight, size, and moisture content.

ACCOMPLISHMENTS: The single kernel NIR system is now commercially available from Perten Instruments (SKCS 4170). Calibrations were developed to identify kernels containing large larvae and pupae, and they were installed on commercial instruments used by flour mills. Protein calibrations are currently being completed.

IMPACT/OUTCOME: This technology will help managers of storage facilities and mills make informed decisions concerning fumigation, that lead to reductions in insect damage and fragments in flour.

evaluate the potential for rapid, objective assessment of starch modification in single kernels of malted barley using physical measures similar to those used for crushing wheat for hardness classification with the Perten SKCS.

ACCOMPLISHMENTS: No progress to report. Project was terminated.

develop and combine a machine vision analysis component with Perten's 4100 Single Kernel Characterization System to increase wheat quality prediction performance. Preliminary studies have demonstrated an increase in the accuracy of hardness classification and the potential for improved flour yield predictions.

ACCOMPLISHMENTS: No progress to report. Project was terminated.

develop a machine vision-based methodology to objectively evaluate bread crumb grain in ARS bake laboratory evaluations of early generation hard winter wheat varieties.

ACCOMPLISHMENTS: ARS efforts in developing a machine vision-based methodology to objectively evaluate bread crumb grain have been temporarily suspended due to the retirement of a scientist in the Engineering Research Unit who was collaborating with the Wheat Quality Laboratory. However, a project was initiated to modify a machine vision-based methodology developed for commercial bakeries for applicable for small loaves of bread baked from an early generation of hard winter wheats.

IMPACT/OUTCOME: Success could lead to an objective grading system of bread crumb grain thereby providing objective quantifiable scores to wheat breeders.

evaluate, in cooperation with GIPSA, the capability of the FOSS Grain Check 310 to assist inspectors in grading wheat. This instrument is one of the first commercially available that uses the principles of image analysis to measure grain quality.

ACCOMPLISHMENTS: Initial and follow-up neural network based calibrations, using wheat samples supplied by GIPSA, showed the potential for machine vision separation of Dark Hard Vitreous (DHV) kernels from non-DHV wheat kernels to be approximately 85 percent correct, while certain types of visually difficult DHV kernels were not well separated.

IMPACT/OUTCOME: With rapid objective classification of DHV wheat kernels, GIPSA could improve inspector efficiency, reduce inspector variations in DHV determination in the market channel, and potentially adopt the procedure for standard market channel use and standardized definitions of DHV wheat.

develop, in cooperation with GIPSA, a knowledge base of the qualitative characteristics that define wheat defects portrayed in the Interpretive Line Slides and develop a machine vision-based inspection system to identify the Line Slide defects in wheat-based on the knowledge base of qualitative characteristics.

ACCOMPLISHMENTS: No progress to report. Project was terminated.

continue to transfer the technology that provides accurate standards for repeatable calibrations of HVI strength measurements of cotton fiber. Research will continue to improve the accuracy and repeatability of other measurements, such as fineness, maturity, color, and length uniformity.

ACCOMPLISHMENTS: A fineness-maturity tester has been developed that provides a secondary standard calibration method. The tester is being evaluated in a round-robin test in many different locations. A very diverse set of cottons was evaluated to determine what best predicts bundle (yarn) strength. The best indicator found is a ratio of fiber fineness to maturity.

IMPACT/OUTCOME: HVI (high-volume instrumentation) is universally used to measure fiber quality, but it has some unresolved issues, including proper calibrations. Currently fineness and maturity are not measured individually, but it is important that procedures be developed to do so. This information is expected to be the basis of the next generation of improved HVI calibration procedures and for adding new HVI tests for fineness and maturity.

PERFORMANCE GOAL 1.1.3.3: Demonstrate methods to measure the critical processing and end-use properties of agricultural commodities important to the agricultural marketing system and the processing industry.

Indicators:

During FY 2000, ARS will

implement a rice database to be used for the measurement of rice quality.

ACCOMPLISHMENTS: A third year of data was collected on some 300 rice cultivars. The near infrared (NIR), mid infrared (MIR) and Raman spectra are being gathered and the protein and amylose data determined. These will be added to the first two years studies which should provide an adequate database to assess end quality of rice.

IMPACT/OUTCOME: Countries which import U.S. rice use NIR to assess quality of the grain. This database will enable the U.S. to export on a level field.

evaluate near infrared transmission spectroscopy to determine quality standards for beef and pork trimmings produced from Advanced Meat Recovery System (AMRS) in cooperation with the National Meat Association and the American Meat Institute Foundation.

ACCOMPLISHMENTS: Developed a near infrared transmission method and calibration for added iron and iron/protein ratio in beef neck bone lean from AMRS and hand boned lean.

IMPACT/OUTCOME: Added iron and iron/protein ratio can be used as a quality or performance standard for bone marrow in AMRS and hand-boned final lean. Thus, the method can be used in meat processing plants to monitor bone marrow content of AMRS final lean.

continue to determine which proteins in wheat are important for specific end-use qualities and investigate the use of protein fingerprints as a means of quality identification.

ACCOMPLISHMENTS: Developed methods that allow rapid identification or fingerprinting of wheat, rice, oats, or barley cultivars in 3 minutes and objective characterization of sorghum and maize proteins in 15 minutes. Developed method to characterize high molecular weight glutenin subunits which correlate to improved bread making properties. Characterized the protein fractions from wheat and related species and correlated them to quality parameters.

IMPACT/OUTCOME: The cereal industry can use these methods for separation of cereal proteins in order to ensure identity of grain lots destined for specific end-uses. Identification of specific proteins and protein fractions may provide a means to predict end-use quality for the cereal industry.

continue to determine the role of lipids in end-use quality of wheat.

ACCOMPLISHMENTS: Continued the development of lipid extraction methods from cereal grains and processed products using supercritical fluid extraction system. The methodology will be collaboratively studied with the American Association of Cereal Chemists and the International Association for Cereal Science and Technology.

IMPACT/OUTCOME: Supercritical fluid extraction provides a much safer, faster, environmentally friendly method for determining cereal lipids. This information may lead to an internationally acceptable standardized method of lipid determination in cereal grains and processed products which has potential importance for cereal-based food nutritional labeling on a global scale.

develop the methods and technology needed to acquire NIR spectral data during flour-water-dough mixing with an instrumented 10 gram mixograph, and relate spectral data to mechanical mixing energy requirements and compositional changes during wheat flour mixing.

ACCOMPLISHMENTS: Developed a database of Fourier-Transform Infrared (FTIR) scans for proteins of known secondary structure to be used in monitoring changes in the secondary structure of gluten proteins in dough during mixing. Began evaluation of a model dough system by FTIR consisting of a mixture of water, starch and vital wheat gluten.

IMPACT/OUTCOME: Techniques and methods for the rapid, nondestructive spectroscopic monitoring and evaluation of dough rheology will ensure more accurate and efficient processing of raw materials in the baking industry.

investigate the potential use of durum wheat translocation lines for bread making.

ACCOMPLISHMENTS: By modifying the baking procedure, discovered that up to 60 percent durum flour could be incorporated in the baking formulation to produce bread with quality characteristics that were equal to or superior to bread made with 100 percent hard red spring wheat flour. In a cooperative study with other USDA scientists, tested the bread making potential of durum wheat translocation lines that contained high molecular weight glutenins from spring wheat. Project will be continued through pilot-scale milling and baking trials.

IMPACT/OUTCOME: Potential for developing a new cultivar of durum wheat that can be specifically used for both bread making and pasta.

STRATEGY 1.1.4: International technology interchange: Develop a strategy for selective international research interchange to supplement ARS technology developments and strengthen competitiveness of U.S. agriculture.

PERFORMANCE GOAL 1.1.4.1: Strategic alliances formed with specific foreign institutions, leading to the joint development of germplasm and value added technologies, mutually protected through intellectual property agreements.

OBJECTIVE 1.2: Develop new uses and products: "Develop new uses and new products for agricultural commodities, such as alternative fuels, and develop new crops."

STRATEGY 1.2.1: New and alternative crops: Develop new and alternative crops with economic and social value.

PERFORMANCE GOAL 1.2.1.1: Experimentally demonstrate the production of new, improved, and alternative crops and horticultural products with potential for successful introduction and demonstrate the successful operation of aquaculture systems.

Indicators:

During FY 2000, ARS will

develop management practices for specialist non-Apis bee pollinators for enhancing commercial production of a new avocado introduced at two groves in Ventura County, California.

ACCOMPLISHMENTS: The study of alternative pollinators is particularly important when crops are introduced into an area where the pollinating insects that co-evolved with the plant are not available. Of four commercially available pollinators (honey bee, alfalfa leaf-cutting bee, blue orchard bee, and western bumble bee) released in two avocado groves in Ventura County, California, by researchers at the ARS Logan, Utah laboratory, western bumble bees actively visited avocado flowers; however, high bumble bee prices make use of these pollinators difficult to justify at this time.

IMPACT/OUTCOME: Surveys of bees that pollinate avocado flowers were conducted at three avocado groves in Atlixco, Mexico, (the area of origin of avocado) by cooperator, Dr. Carlos Vergara (Universidad de las Americas). Data from these studies will be used to identify bee species most commonly associated with avocado pollination, with the goal of finding a more efficient and less expensive pollinator than those currently available.

improve guayule production by working with cooperators to identify strategies necessary to control annual and perennial grasses and broadleaf weeds, determine the optimum time for seed harvest, and develop methods for optimizing the yield and quality of guayule latex.

ACCOMPLISHMENTS: ARS scientists and cooperators at Texas A&M University planted guayule seed in Arizona experiments on control of grasses and weeds and optimization of production. However, the seed quality was inferior and the germination poor, so the experiment was terminated but will be repeated in the coming year.

IMPACT/OUTCOME: Due to poor seed germination, the year 2000 tests failed, therefore, no impact or outcome could be measured.

develop and release a root knot nematode resistant Habanero-type pepper. The pepper is an extremely pungent one (Capsicum chinese) that is becoming popular in the U.S. however, it is susceptible to root knot nematodes, as are all known commercial cultivars. A conventional backcross breeding procedure is being used to move a highly effective resistance gene from a Scotch Bonnet-type germplasm line into commercial Habanero. ARS is ready to initiate the third backcross cycle, and anticipates having advanced breeding lines ready for release by the end of FY 2000.

ACCOMPLISHMENTS: The root-knot nematode resistance from Scotch Bonnet-type pepper germplasm was moved to three advanced breeding lines of Habanera-type pepper that have been released to breeders for cultivar development. In addition, the root-knot nematode resistance was moved into two bell-type pepper varieties that were released under the names "Charleston Wonder" and "Charleston Belle."

IMPACT/OUTCOME: This germplasm will reduce the amount of chemical nematicides required for pepper production and should also reduce the dependency on methyl bromide for pre-plant soil fumigation.

develop micro-quantification methods for rubber analysis so that guayule plants can be evaluated for potential performance while young instead of at least two years old.

ACCOMPLISHMENTS: A new method was developed capable of determining latex content of very small amounts of guayule plant tissue.

IMPACT/OUTCOME: The method is currently in use to evaluate guayule germplasm lines and to enhance latex processing procedures. This procedure will considerably speed up the research program. A CRADA is in place with a company to commercialize hypoallergenic latex rubber from guayule. Each year that mass production of hypoallergenic guayule latex rubber is accelerated means that millions of sufferers from latex allergy will no longer be at risk of serious reactions, even death.

begin testing rubber yield and quality from genetically engineered guayule.

ACCOMPLISHMENTS: For the first time, guayule has been genetically engineered to produce stable transformants. Three guayule genetic lines have been transformed with genes believed to be important in determining rubber yield, but will maintain the valuable hypoallergenic quality of the latex. Greenhouse plants have been successfully regenerated from the genetically engineered cells, as the first step in generating a population of transformed plants for evaluation.

IMPACT/OUTCOME: For the first time, geneticists have germplasm that has the potential to increase yield when introduced into a breeding program. Natural rubber is a strategic product for which the U.S. is entirely dependent upon imports. An enhanced guayule plant, which can produce high yields in the Southwestern U.S., will reduce the dependence upon precarious foreign sources of Hevea rubber.

plant large test plots of elite cuphea varieties in the Midwest in cooperation with farmers and 100 acres of lesquerella in the Southwest, both of which could produce oils for use in industrial products.

ACCOMPLISHMENTS: Poor seed set of Cuphea during seed production in 1999 resulted in a small harvest, and precluded the planting of large test plots of elite cuphea in 2000; however, a small test plot of an elite nonsticky, nondormant cuphea line was planted next to corn in central Illinois and harvested successfully.

Two new lesquerella germplasm lines, one with increased seed oil and yield and one with tolerance to saline soils, were released. A test plot of 40 acres of lesquerella was planted in Arizona and the seed oil extracted in Nebraska for evaluation in the manufacture of industrial lubricants.

IMPACT/OUTCOME: The oil produced from Cuphea can be used as a substitute for imported palm oil for the manufacture of detergents and industrial lubricants. Field tests in 2000 demonstrated that Cuphea can be successfully grown in the Midwest as an alternative crop that can be used in rotation with soybean and corn. The new lesquerella lines will improve yields for producers and processors.

PERFORMANCE GOAL 1.2.1.2: Experimentally demonstrate new and improved production, harvest, and postharvest handling procedures of these crops.

Indicators:

During FY 2000, ARS will

develop microquantification methods for rubber analysis so that quayule plants can be evaluated for potential performance while young instead of at least two years old.

ACCOMPLISHMENTS: Microquantification methods for rubber analysis based on measuring enzyme activity were developed for evaluating small amounts of plant material. These methods can be used for evaluating small plants grown in the greenhouse or field.

IMPACT/OUTCOME: Use of these methods will allow earlier evaluation of breeding materials for rubber content, reducing the developmental time for new germplasm by almost two years and allowing evaluation of plants when maximum genetic expression is occurring without confounding environmental effects.

begin testing rubber yield and quality from genetically engineered guayule.

ACCOMPLISHMENTS: Genetically engineered guayule plants with potentially higher rubber contents were developed and plantlets increased in the greenhouse for experimental field planting in the Spring of 2001.

IMPACT/OUTCOME: These plants could potentially have more than the 10% rubber in the highest yielding lines developed by traditional breeding methods.

STRATEGY 1.2.2: New uses and products: Develop new food and nonfood uses and products from plants and animals, and new processes and other technologies that add value.

PERFORMANCE GOAL 1.2.2.1: Experimentally demonstrate improvements in processing technologies and develop new bioproducts and uses that have potential to increase demand for agricultural commodities.

Indicators:

During FY 2000, ARS will

establish the field efficacy of organic based flocculants and soil stabilizers to control irrigation induced soil erosion. NRCS, irrigators, consultants and other water users will be able to use this technology to control soil erosion using "natural" compounds that readily degrade in the environment.

ACCOMPLISHMENT: Scientists at Kimberly, Idaho, have shown that polyacrylamide (PAM) when applied at 10 parts per million the irrigation water reduced sediment losses by more than 95 percent from the furrow

irrigated fields. And, in cooperation with private industry, the scientists developed a method to measure residuals to determine if PAM could pose a health effect.

IMPACT/OUTCOME: To date no residuals have been found in crop tissues or in downstream waters. PAM is currently being used on about 6 million acres.

complete development of extruded high fiber and high energy food bars using milk components for possible use in school lunch and other domestic programs.

ACCOMPLISHMENTS: Demonstrated that milk proteins may be used as part of a formulation for an extruded high dietary fiber food bar. The milk proteins function as a binder that holds the starch components and the fiber to form a cohesive, firm and chewy product.

IMPACT/OUTCOME: This technology provides a means of increasing the amount of dairy proteins and dietary fiber that may be included in a food bar, used increasingly by United States consumers for meal replacement, improving its nutritional benefits while maintaining its palatability.

conduct research with an industrial partner through a CRADA to complete research necessary for commercialization of Zeagen corn fiber gum, a substitute for imported Arabic gum.

ACCOMPLISHMENTS: Research led to a joint patent on the new corn fiber gum technology being granted to ARS and its commercial partner on November 14, 2000.

IMPACT/OUTCOME: Having obtained a patent on the new technology, the industry partner will be able to justify expenditure of funds needed to scale up and commercialize the product. Sales of this new product will increase the value of corn fiber and provide more revenue to corn producers and wet-millers.

test and modify low oil uptake rice batter for various fried food applications and obtain a more comprehensive scientific understanding of the mechanisms of oil uptake. This will be done in cooperation with a CRADA partner.

ACCOMPLISHMENTS: A process was developed for low oil-uptake donuts formulated with wheat flour and up to 50 percent rice ingredients. They absorb 50-70 percent less oil than traditional wheat, while retaining desirable flavor and textural characteristics. Discussion is ongoing with potential CRADA partner.

IMPACT/OUTCOME: This technology meets the needs of health-conscious consumers, and could spur demand for donuts which, in turn would increase utilization of rice.

continue to develop an improved phytase, including a reduced-cost plant produced phytase. Phytase is an animal feed additive that reduces the level of phosphorus in animal manure and protects the environment. Recent evidence linking Pfiesteria fish kills to runoff from animal production facilities has spurred interest in phytase as a means of helping abate future Pfiesteria-caused fish kills.

ACCOMPLISHMENTS: Several modified phytases have been engineered for evaluation as improved means to reduce phosphorous levels in manure from monogastric farm animals.

IMPACT/OUTCOME: Development of an improved phytase would increase its use in animal feeds in the U.S. with subsequent reductions in phosphorous-rich runoffs from animal manures.

work with American tanneries to apply ARS technology to recover chromium in the solid waste byproducts from the tanning process. The recovered chromium is recycled back into the tanning process. Collagen which is also recovered from the solid waste has commercial value.

ACCOMPLISHMENTS: Evaluated specific protease enzyme and found that 95 percent of the available

protein could be recovered from the shavings, leaving a nearly protein-free chrome cake suitable for recycling into further tanning processes. University collaborators reported on their attempt to adapt the process for production of a specific product.

IMPACT/OUTCOME: Accomplishment will benefit the leather producer and the processor of tannery wastes, and help direct landfilled waste into processes that recover valuable products from that waste. Scientists in three countries have contacted ARS concerning possible use of the technology.

demonstrate the potential of natural fiber reinforced starch foam materials by moving innovations from the laboratory to the pilot plant stage with industrial partners.

ACCOMPLISHMENTS: ARS scientists extruded a series of materials and showed that the addition of fiber increased the compressive strength above that of foams of comparable density, especially at low relative humidity, and significantly increased the axial compressive strength.

IMPACT/OUTCOME: A manuscript was prepared and sent to the cooperator, but no response was received.

execute license agreements for intellectual property rights on biobased material for synthetic skin to treat burns and wounds.

ACCOMPLISHMENTS: Working with a small biomedical business, a license for the biobased Fantesk technology was negotiated and signed.

IMPACT/OUTCOME: A new market for starch and vegetable oils was created.

commercialize guayule latex as a safe alternative to natural rubber for future production of hypoallergenic latex products by the industrial sector.

ACCOMPLISHMENTS: Developed a preliminary crop model to maximize post-harvest latex production throughout the year. Generated 10 gallons of pure latex under a trust fund with a USDA patent licensee. USDA patent licensee has begun first guayule planting for commercial nonallergenic latex production. Seed pretreatments were developed that led to successful field trials of USDA germplasm under a specific cooperative agreement with the Agricultural Research Council of South Africa.

IMPACT/OUTCOME: Guayule latex is a safe alternative to natural rubber for production of nonallergenic latex products by the industrial sector in the future.

seek licensees and a CRADA partner to explore the potential for developing large-scale manufacturing methods of a lightweight concrete based on wheat starch gels.

ACCOMPLISHMENTS: More than 50 national and international companies have made inquiries about the product. A CRADA was signed with a private sector partner to test starch-based lightweight concrete in a decorative siding product. The tests indicated that the starch-based concrete needed a higher compressive strength to meet code requirements. The CRADA partner suggested other possible niche markets that might benefit using starch-based lightweight concrete.

IMPACT/OUTCOME: The potential impact of this research will depend on whether a company can be found for exploiting starch-based concrete to fill a niche market. Success would create new markets for U.S. wheat producers.

investigate the viability of Fantesk technology in food applications, metal working fluids, and medical applications in cooperation with industrial CRADA partners. Potential areas of commercialization will be pursued.

ACCOMPLISHMENTS: Work with two small businesses under separate CRADA's led to the development of (1) lotions and barrier cream formulations which were subjected to clinical testing by the cooperator and (2) breadings for use in seafood products. Successful execution of the projects led to licensing of the technology by both of the cooperators.

IMPACT/OUTCOME: Potential new markets for starch and vegetable oils derived from corn and soybeans.

investigate the viability of utilizing cereal proteins as components for blends in the production of new biodegradable plastics in cooperation with the Biotechnology and Development Corporation.

ACCOMPLISHMENTS: Working under a CRADA agreement, protein-based blends were produced which possessed mechanical properties similar to petroleum-based thermoplastics. The materials could be processed using standard commercial equipment. A patent application for the technology has been submitted with the CRADA partner and licensing of the technology is being pursued.

IMPACT/OUTCOME: Potential new industrial markets from proteins obtained from wheat and soybeans.

investigate dry grind ethanol byproduct streams such as "quick corn fiber" and distillers dry grains as alternative feedstocks for new functional (nutraceutical) food products.

ACCOMPLISHMENTS: ERRC, NAA, ARS scientists in Wyndmoor, Pennsylvania, found that high-valued nutraceuticals, such as cholesterol-lowering phytosterols and functional food gums could be generated as co-products from current or slightly-modified dry-grind ethanol processes. Previously, these valuable co-products could only be produced with more capital intensive wet-milling processes.

IMPACT/OUTCOME: These results demonstrate the possibility of expanding the range and value of co-products produced during production of fuel ethanol at small, less-costly, dry-grind ethanol facilities. The sales of these co-products can lower the cost of producing fuel ethanol and bring more revenue to small processors and their communities.

develop and evaluate a new low cost method for extraction of valuable pectin from surplus U.S. citrus processing residues.

ACCOMPLISHMENTS: Developed a new method for rapid extraction of pectin using microwave heating and used it to extract pectin from orange peels more quickly and with superior quality compared to pectin produced by conventional commercial means.

IMPACT/OUTCOME: Research demonstrated that pectin production costs could be reduced without sacrificing quality of the final product. Adoption of the method by commercial producers will lower pectin costs, making it more competitive with other food gums and thereby expanding its applications and use.

complete development of a new, lower cost extrusion method to produce biodegradable packaging and edible films from pectin, corn starch, and glycerol.

ACCOMPLISHMENTS: Demonstrated that blends of pectin/starch/glycerol could be extruded into materials having mechanical properties comparable to those obtained from the more expensive solution casting method.

IMPACT/OUTCOME: Results demonstrate how edible, pectin-based films can be formed cost-effectively with equipment currently used by manufacturers of non-edible films. Adoption of the fabricating technique by producers will create new markets for pectin and thereby increase demand for pectin and U.S. citrus peel.

process up to 75,000 pounds of lesquerella seed to produce crude and refined oil, lesquerolic acid, and meal for industrial partners to use in developing industrial markets.

ACCOMPLISHMENTS: 24,000 pounds of lesquerella seed was harvested and cleaned. Process equipment was installed at a new small processing facility for lesquerella, milkweed, and other alternative crops.

IMPACT/OUTCOME: An economic and research plan to commercialize lesquerella was initiated.

GOAL II: To Ensure an Adequate Food Supply and Improved Detection, Surveillance, Prevention, and Educational Programs for the American Public's Health, Safety and Well-being.

Analysis of Results: This is the focus of much of ARS' research related to food safety and the security of the U.S. agricultural production system. Under Goal II, 72 Indicators are aligned under 9 Performance Goals. Because of the unique and dynamic nature of research, several Indicators were added to the Report that did not first appear in the Annual Performance Plan for FY 2000. This was done to ensure that significant accomplishments that were not anticipated last year were reported. While it is not possible to report research accomplishments numerically, the progress projected in all 71 Indicators was completed or substantially completed during FY 2000.

OBJECTIVE 2.1: Secure food and fiber system: Maintain a safe and secure food and fiber system that meets the Nation's needs now and in the future.

STRATEGY 2.1.1: Plant and animal production systems: Improve efficiency of agricultural production systems to ensure the security of the Nation's food, fiber, and energy supply.

PERFORMANCE GOAL 2.1.1.1: Demonstrate increases in productivity above current levels using sustainable technologies.

Indicators:

During FY 2000, ARS will

develop diverse sources of sunflower germplasm with economically important traits and adaptability to U.S. growing conditions, and investigate genetic inheritance of these traits leading to improvements in production performance.

ACCOMPLISHMENTS: Using wild perennial sunflower as a germplasm source, scientists transferred genes for broomrape resistance into intermediate breeding lines. These intermediate sunflower lines were provided to cooperators in Spain for development into cultivated, broomrape-resistant sunflower.

IMPACT/OUTCOME: A new race of broomrape, a parasitic disease of sunflower, has emerged in Southern Europe and Turkey, and no current sunflower hybrids have resistance. The release of sunflower germplasm with resistance to this new virulent race of broomrape provides an important weapon to sunflower breeders in countries where the disease threatens the future of the sunflower industry. The germplasm ensures that U.S. farmers will have a source of resistance to this parasitic pest in the event of its accidental introduction into the U.S.

develop sunflower germplasm with altered fatty acid composition to provide improved vegetable oils for the sunflower industry.

ACCOMPLISHMENTS: ARS researchers developed and released female and male sunflower lines that can be used to produce the NuSun sunflower hybrid. The new sunflower has an oil composition with improved health benefits and excellent stability under frying conditions.

IMPACT/OUTCOME: The release of female and male sunflower germplasm lines with the NuSun trait will allow seed companies to develop NuSun hybrids with precise fatty acid composition for planting by farmers. Sunflower hybrids produced by these lines have excellent disease resistance, high yield, and acceptable oil content, all of which will benefit both producers and processors.

expand and diversify the ARS sunflower collection through additions of under-represented species from Mexico and the U.S.

ACCOMPLISHMENTS: An ARS botanist conducted an exploration in Arizona, Utah, and Nevada, collecting several wild sunflower species. Two of the species, *Helianthus anomalus* and *Helianthus deserticola* had been seriously under represented in the ARS sunflower germplasm collection.

IMPACT/OUTCOME: The addition of these new accessions to the sunflower germplasm collection at Ames, Iowa, will provide a potential new source of genes for drought tolerance in sunflower.

develop the means to improve the safety of peanuts by developing germplasm with improved resistance to aflatoxin contamination and acceptable agronomic performance.

ACCOMPLISHMENTS: ARS scientists and cooperators at the University of Arizona conducted large scale field screening of over 100 peanut breeding populations for resistance to aflatoxin contamination, and identified 17 lines that showed at least a 50 percent reduction in aflatoxin contamination.

IMPACT/OUTCOME: The results demonstrated that reduction of aflatoxin contamination in peanut is possible through selective breeding with available peanut germplasm. This will stimulate additional breeding efforts that are likely to reduce aflatoxin contamination even further.

develop alternative weed management systems for irrigated peanuts with less dependence on herbicides.

ACCOMPLISHMENTS: ARS scientists and cooperators at the University of Georgia developed alternative weed management systems in peanut production. One system involves cultural practices: narrow rows to improve peanut's competitive ability; and stale seedbed tillage, which reduce numbers of weed seeds in soil before planting. A second system is strip-tillage, wherein densities of some weeds were less than in conventional tillage, but inability to control other weeds actually increased dependence on herbicides. Another accomplishment was alternative applications of dinitroaniline herbicides in reduced tillage systems and leadership in the effort to amend herbicide registrations to allow these new uses.

IMPACT/OUTCOME: Peanut growers who use narrow rows and stale seedbeds reduce the need for commonly used late season herbicides. Cost of implementing these alternatives is minimal since no additional inputs are required and, depending on weed species composition, growers save \$20/A by using less herbicide. Strip tillage simplifies crop production and spreads workloads through the season, which compensates for higher weed control costs. In this latter system, growers were warned to expect difficulties in managing Texas panicum and common bermuda grass.

develop peanut germplasm with improved resistance to peanut root-knot nematode, a serious pathogen.

ACCOMPLISHMENTS: ARS researchers developed an advanced generation peanut breeding line with a high level of resistance to the peanut root-knot nematode.

IMPACT/OUTCOME: The peanut root-knot nematode is a significant economic pathogen of peanut in the Southeast. This is the first discovery of peanut genetic material with resistance to both the root-knot nematode and tomato spotted wilt virus, another serious disease of peanut in this region.

develop improved lines of soybean for yield and seed quality traits and release them to the public.

ACCOMPLISHMENTS: ARS scientists released a high yielding experimental soybean line, LG96-1797. Researchers also identified several high protein experimental lines and evaluated primitive soybean germplasm, finding large differences in isoflavone contents among lines.

IMPACT/OUTCOME: Soybean line LG96-1797 was derived from exotic germplasm not found in the pedigrees of current commercial cultivars. Although this line does not exceed the yield of present high-yielding cultivars, its value lies in the genetic diversity it adds to soybean production. The identification of experimental lines with high protein or variability in isoflavones, thought to be dietary protectants in human health, indicates the potential for improvement of these two quality factors.

transfer new knowledge to the food and feed crop pollination industry to enhance food production through improved pollination of cranberries, blueberries, sunflowers, legume forage, oil seed crops, pears, apples, cherries, almonds, and other orchard crops by bee pollinators - alfalfa leafcutting bees, blue orchard bees, western bumble bees, sunflower leafcutting bees, southeastern blueberry bees, alkali bees, hornfaced bees, and mustached bees.

ACCOMPLISHMENTS: In Northern Utah, the ARS Logan laboratory demonstrated the value of the blue orchard bee for pollination of commercial cherry. Yield more than doubled compared with using honey bees. Blue orchard bee pollination was facilitated by use of a new nesting material and nest design, for which ARS has received conditional patent approval. In field trials, ARS also demonstrated the use of meadowfoam, an oil-seed crop produced in the Willamette Valley of Oregon, as a forage crop to increase populations of the blue orchard bee for use in California cherries and almonds.

In an effort to reduce 20 to 60 percent losses of bees routinely suffered by alfalfa seed producers each year, ARS entered into a collaborative research effort with BASF (formerly, American Cyanamid) directed toward the development of alternatives to methyl bromide for the management of chalk brood (a fungal disease of all bees) in commercial populations of the alfalfa leafcutting bee.

In the Walla Walla, Washington seed alfalfa region, ARS documented a dramatic one-year increase in nesting densities of the alkali bee. Hybrid onion planted adjoining an alkali bee nesting bed was used exclusively by alkali bees (alfalfa's best native pollinator) for nectar. Seed production will be evaluated this fall to determine if onion is a profitable nectar crop to supplement the needs of this bee.

Having established that the sunflower leafcutter bee is a much more efficient sunflower pollinator in cages (on seeds produced per bee basis) research, in collaboration with Pioneer Hybrid International, focused on the optimal number of bees per plant to include in each cage. Results will be used to set bee stocking rates for seed producers.

IMPACT/OUTCOME: The ARS Logan laboratory initiated a 5-year collaborative project with USDI-BLM to assess pollinator diversity patterns in the Grand Staircase-Escalante National Monument. This project will provide baseline data for monitoring ecosystem health through the use of bee pollinators as indicator species.

field test and transfer to cattle growers and others in the animal industry new knowledge on increased productivity through the use of integrated management methods for the control of gastrointestinal nematodes in pasture and range cattle.

ACCOMPLISHMENTS: ARS scientists at Beltsville, Maryland, have developed a DNA based assay to diagnose and quantitate *O. ostertagi* infections in cattle from fecal eggs. In the past, testing began on the molecular assay on fecal samples collected from cattle grazing infected pastures to validate the use of the assay under field conditions.

IMPACT/OUTCOME: Once validated, this assay will be used to identify individual members of the herd which account for the majority of parasite transmission, thus allowing for targeted parasite control programs. This assay will be used by industry scientists as a faster and more quantitative method to determine the efficacy

of drug treatments for parasite control.

continue to develop and test elite, heat resistant lines of pima cotton with outstanding fiber quality, resulting in the eventual release of improved germplasm for use by breeders to produce new varieties.

ACCOMPLISHMENTS: In a collaborative effort involving USDA-ARS, New Mexico State University, and the University of California, Los Angeles, genes controlling stomatal conductance in Pima cotton have been localized in two chromosomal regions. The genes provide heat tolerance for this crop, whose yields are generally limited because of excessive heat in its growing areas.

IMPACT/OUTCOME: Pima cotton is grown on about 300,000 acres in the Southwestern U.S. and is severely limited by heat. This research provides a new method to incorporate heat tolerance in varieties much faster than would occur otherwise. Yield increases of 25 percent or more are possible.

evaluate the effects of red plastic mulch in the field on the quality of cotton fiber. The mulch is known to alter the spectrum of light in the cotton crop canopy which results in increased fiber length. Studies in 2000 and 2001 will evaluate the utility of light change and begin to understand how this effect can be agronomically manipulated.

ACCOMPLISHMENTS: The effect of red or green mulch (which reflect colored light into the canopy) was exerted directly on cotton bolls rather than leaves. Covering bolls with aluminum foil removed the fiber-enhancing effect. Cotton fibers over red or green mulch were up to 4 mm (5/32 inch) longer, and slightly finer, than controls. The effect of green mulch indicates that reflected light onto bolls from nearby green leaves can have a major effect on fiber length.

IMPACT/OUTCOME: U.S. cotton mills utilize about 11 million bales of U.S.-produced cotton each year. Increased fiber length will greatly improve spinning efficiency in cotton mills, especially with new high-speed machinery. This trait will add greatly to the global competitiveness of both the U.S. cotton farmer and the U.S. cotton mills, which use the majority of U.S. produced fiber.

PERFORMANCE GOAL 2.1.1.2: Demonstrate a more efficient and cost effective use of resource inputs while increasing productivity above current levels.

Indicators:

During FY 2000, ARS will develop microorganisms and determine optimum conditions to preserve protein in silage to conserve forage for livestock.

ACCOMPLISHMENTS: The U.S. Dairy Forage Research Center, Madison, Wisconsin, refocused on the source of protein rather than the development of organisms. Researchers found that protein in red clover conserved in silage was utilized more efficiently than protein in alfalfa conserved in silage.

IMPACT/OUTCOME: This improvement in nitrogen efficiency applied to only the first half of lactation (when cows need more protein) reduces nitrogen excretion 1.5 ton per year for a 100 cow herd.

STRATEGY 2.1.2: Plant, animal, and ecosystems protection: Improve integrated management systems that contribute to the protection of plants, animals, and ecosystems against pests (insects, weeds, pathogens, etc.).

PERFORMANCE GOAL 2.1.2.1: Demonstrate new integrated technologies to protect plants, animals, and ecosystems.

Indicators:**During FY 2000, ARS will**

*continue to monitor the resistance of insect pest populations to transgenic plants that contain the toxin gene from *Bacillus thuringiensis* (bt). This activity is part of a long-term strategy to keep transgenic pest resistant crops effective, so they can continue to be used in IPM strategies to reduce chemical pesticide use.*

ACCOMPLISHMENTS: Bt cotton has proven effective in controlling cotton bollworms. However, the potential development of resistance is a growing concern. ARS scientists at Stoneville, Mississippi, developed a more rapid and sensitive bioassay procedure to better identify cotton bollworms with resistance to Bt cotton. The bioassay requires only a minimum of five insects collected from the field to identify resistance genes. The scientists demonstrated that commercial cultivars of transgenic Bt cotton do not provide the same level of activity against caterpillar pests since the amount of Bt present in the plant is cultivar dependent.

IMPACT/OUTCOME: The U.S. Department of Agriculture's Agricultural Research Service has been the agency responsible for conducting a Bt resistance-monitoring program in the Southern U.S. The new resistance monitoring bioassay developed by ARS is an essential tool for the resistance-monitoring program and for the early detection of Bt resistance in cotton bollworm populations from the 12 cotton-growing states located in the Southern U.S. The utility of the system has been demonstrated as reliable both abroad (cotton in Australia) and in the Southern U.S. so that alternative tactics can be used in areas where resistance to Bt transgenic cotton appears. The technology will help growers in their cultivar selections as well as providing insight into population dynamics of migratory moths in transgenic crops.

continue the five-year corn rootworm areawide IPM program in the Midwestern U.S. using attract and kill technology.

ACCOMPLISHMENTS: Corn rootworms are the targets of almost half of the insecticides used in row crops. ARS' 5-year areawide IPM program in Indiana, Illinois, Kansas, Iowa, and Texas, using an adult corn rootworm attract and kill technology, reduces corn root worm more than 70-90 percent in most of the test sites. In FY 2000, new baits and trapping systems were evaluated at the five primary sites which showed substantial Western corn rootworm population reductions across the Midwest demonstration sites. A number of corn growers have expressed interest in undertaking their own programs using the adult attracticide technology.

IMPACT/OUTCOME: A 90 percent reduction in the amount of prophylactic soil insecticide applied to U.S. corn grown in the Midwest U.S. can result in \$300 million estimated savings. The program led by ARS out of Brookings, South Dakota was initiated in 1996 with substantial partner involvement from the University of Illinois, Purdue University, Iowa State University, South Dakota State University, Kansas State University, University of Nebraska, Texas A&M, and corn growers. The team received a USDA-ARS Technology Transfer award for this National IPM program across the U.S. corn belt. Program expansion and technology transfer has been particularly significant in Kansas and Texas, thus far.

complete the five-year areawide IPM program to control codling moth on apples and pears using mating disruption in the Pacific Northwest U.S.

ACCOMPLISHMENTS: The areawide pest management for codling moth has now successfully completed its final year. The Western Region of the Nation includes 54 percent of U.S. apple production acres and 97 percent of pear production. The codling moth is the key pest of pears and apples in that area. Traditional pest control methods, chiefly multiple sprays with organophosphate insecticides, which are at-risk pesticides, have led to the development of resistant strains of codling moth, reduced populations of beneficial insects, increased secondary pest outbreaks, and increased concerns over farm worker safety. ARS scientists at Wapato, Washington have led an areawide management partnership program since 1995 across the three State area of Washington, Oregon, and California using mating disruption, sanitation, natural enemies, and early season Bt sprays. Since the beginning of the program, insecticide use has significantly declined with

some orchard growers not having sprayed for codling moth or other orchard pests, a decline of as much as 70 percent - 90 percent being realized.

IMPACT/OUTCOME: In 1995, there were 68 growers and 3,109 acres (five sites) in the program. In 1999, more than 600 growers and 21,000 acres (22 sites) had entered the program. The technology has now been accepted by many growers across the region. In Washington State alone, the number of acres within and outside the program has increased from 24,000 in 1997 to more than 60,000 in 1999, and in the three state area the number of acres grew to over 125,000 in 2000 under the technology, and several thousands of acres in California and Colorado. It is estimated that the orchard growers realize a savings of \$400 per acre using mating disruption at the main tactic, since the use of the primary insecticide, Guthion, has decreased. ARS research and technology transfer partners were significant and included Washington State University, Oregon State University, the University of California, and numerous growers and consultants.

expand testing of naturally derived materials that reduce populations of blue-green algae in catfish ponds.

ACCOMPLISHMENTS: Scientists at the National Products Utilization Research Unit, Oxford, Mississippi, have selected one of several natural product-based blue-green algaecides for further testing and development.

IMPACT/OUTCOME: Potential not demonstrated.

continue developing an attractant for Asian longhorned beetle for use as a survey tool to protect urban trees and forests from infestation.

ACCOMPLISHMENTS: In the U.S., the Asian longhorned beetle (ALB) was first found infesting trees in New York in 1996 and in Chicago in 1998. If the ALB spreads unchecked into U.S. urban and forest landscapes, it could cause billions of dollars in damage to ornamental and forest trees and to the maple syrup, lumber, and tourism industries. ARS scientists at Beltsville, Maryland, have discovered and synthesized a potential attractant for the ALB. The scientists are proceeding with evaluations of the attractant to ascertain its usefulness and with pursuing a patent on the attractant.

IMPACT/OUTCOME: A useful attractant for the Asian longhorned beetle could be developed into a detection and survey tool as a means to intercept and destroy the pest, if it proves to be effective over a reasonable distance in the field.

expand testing of a new melon derived attractant for corn rootworm for use in attract and kill programs.

ACCOMPLISHMENTS: The goal of this effort has been to develop a new effective, nonpolluting attracticide pest management strategy for control of adult corn rootworms. Scientists at Beltsville, Maryland, have developed a new bait derived from Hawkesbury watermelon. The bait has undergone successful areawide testing and is undergoing commercial development. Based on field trials, the use of the bait is being expanded to more than 50,000 acres on corn and soybeans in the Midwest, including Texas, Kansas, Iowa, Illinois, Indiana, Nebraska, and South Dakota.

IMPACT/OUTCOME: The new product, commercially identified as Invite, and marketed by Florida Food Products, AgroTech, Inc., adds another new attracticide product for control of adult corn rootworm. Two patents have been awarded for the new bait system and it has been licensed by industry. Full commercialization of this technology should result in widespread use of the bait in formulations for control of corn rootworms, and reduce by 90 percent the amount of soil insecticides being applied to soil for corn rootworm control.

STRATEGY 2.1.3: Germplasm resources and genomics: Acquire, preserve, evaluate, describe, and enhance genetic resources and develop new knowledge and technologies to increase the productive capacity and usefulness of plants, animals, and other organisms.

PERFORMANCE GOAL 2.1.3.1: Collections of well documented germplasm of importance to U.S. agricultural security are readily available to scientists and breeders for research and development.

Indicators:

During FY 2000, ARS will

release and genetically characterize improved germplasm lines of grain crops designed to optimize their utility for specific feed, food, and health beneficial uses.

ACCOMPLISHMENTS: Nutritional assessments have been conducted on low phytic-acid corn and barley lines, originally developed by ARS scientists at Aberdeen, Idaho, to reduce phosphorus run-off from animal feedlot operations. Cooperators at the University of Colorado found that human subjects retained 70 percent more zinc from foods prepared with low phytic-acid corn compared to normal corn. Cooperators at Montana State University found that heifers gained up to 33 percent more weight per day when fed low phytic-acid barley compared to normal barley.

IMPACT/OUTCOME: Low phytic-acid corn and barley lines may provide enhanced nutritional value for humans and livestock, as well as improve phosphorus nutrient management.

release and genetically characterize improved germplasm lines of grain crops with improved levels of resistance to important existing and emerging disease organisms.

ACCOMPLISHMENTS: The fungal disease, scab (*Fusarium* Head Blight) has caused devastating losses to the wheat industry. ARS scientists and university collaborators at Fargo, North Dakota, have incorporated scab resistance from wild relatives of wheat to produce new durum wheat germplasm lines with scab resistance, and released a new hard red spring wheat variety 'Alsen' with a higher level of scab resistance. Crown rust is a major disease of oat. Protection against this oat disease has previously depended on a single gene for resistance, which often became ineffective soon after a new oat variety was released. ARS scientists and university cooperators at St. Paul, Minnesota, have now identified a general (nonspecific) type of resistance, conferred by a group of genes, that is effective against many strains of the crown rust organism. The most destructive disease of rice in California is stem rot. ARS scientists at Davis, California, and collaborators at Biggs, California, have identified two DNA markers linked to stem rot resistance from a wild rice species.

IMPACT/OUTCOME: Transfer of the wild grass chromosome segment containing scab resistance into the durum genome was confirmed. The new durum germplasm lines can be used to speed up breeding of new durum wheat varieties with scab resistance. The new bread wheat "Alsen" with increased tolerance to scab will likely be widely adopted by growers in areas previously damaged by scab. (2) General (nonspecific) genes often provide long lasting resistance to crop disease pathogens. DNA markers associated with the durable, general-resistance genes have been identified and can now be used by oat breeders to effectively incorporate crown rust resistance into new oat varieties. (3) Identification of DNA markers linked to stem rot resistance could significantly accelerate the transfer of these genes into high-yielding rice varieties.

acquire, preserve, characterize, document, evaluate, and enhance crop, microbial, and beneficial insect genetic resources so that U.S. crops and beneficial microbes are less genetically vulnerable, an optimal repertoire of genes are accessible for continual crop and microbial improvement through genetic gain.

ACCOMPLISHMENTS: The ARS National Plant Germplasm System (NPGS) is the premier plant genebank network in the world, managing more than 430,000 different samples invaluable for crop genetic improvement and scientific study. More than 120,000 of these samples (almost 30 percent of the total) were distributed in 2000 in response to more than 3,000 different requests. More than 4,000 different samples were increased in 2000 by controlled field cultivation. More than 80 percent of all the seed-propagated accessions are backed

up in security storage at the National Seed Storage Laboratory. In 2000, 9 foreign plant explorations were conducted successfully. More than 600 accessions of cotton were acquired from Uzbekistan, material that may provide critical new genetic diversity for the U.S. cotton crop. The preceding activities enabled the scientific community to gain ready access to a wide diversity of genetic materials for research and crop improvement.

IMPACT/OUTCOME: The website for the NPGS public database, the Germplasm Resources Information Network (GRIN), was queried thousands of times per day through the World Wide Web. An average of more than 450 new "visitors" queried GRIN every day during 2000. This high frequency of usage indicates that this database is a key resource for plant researchers and breeders worldwide.

ACCOMPLISHMENT: The ARS microbial germplasm collections now manage more than 100,000 different strains of bacteria, fungi, and related microbes. The largest collection at Peoria, Illinois, manages more than 80,000 different strains, including germplasm vouchers of patented microbes.

IMPACT/OUTCOME: These microbial collections serve as an important reference standard for microbial identification, as biocontrol agents, and as sources of natural products for pharmaceutical and other industrial uses.

ACCOMPLISHMENTS: Sugarbeet is one of the most important sources of domestic sugar, and a mainstay of the agricultural economy in the Northern Great Plains. Sugar content and disease resistance are key productivity factors for sugarbeets. ARS scientists at East Lansing, Michigan, developed new methods for assaying sugar content of single plants (via High-Performance Liquid Chromatography) and single plant assays for disease resistance to an important sugarbeet seedling disease.

IMPACT/OUTCOME: These new techniques may accelerate the pace of sugarbeet genetic improvement.

ACCOMPLISHMENTS: By evaluating hundreds of cotton germplasm lines, ARS researchers at Starkville, Mississippi, identified non-U.S. germplasm with resistance to tobacco budworm, one of the most serious cotton pests.

IMPACT/OUTCOME: These resistant materials will provide the basis for breeding resistance into cotton germplasm adapted to the U.S.

ACCOMPLISHMENTS: In tomatoes, beta carotene confers superior nutritive properties. ARS scientists at Beltsville, Maryland, identified DNA genetic markers for accurately predicting beta carotene content.

IMPACT/OUTCOME: These markers may improve the efficiency of tomato breeding and hasten the development of tomatoes with superior nutritional content.

ACCOMPLISHMENTS: Nematicides are very expensive, especially for small producers, and those who produce vegetables such as carrots for "organic" or "low-input" niche markets. Consequently, carrots with genetic resistance to nematodes are highly desirable, because the latter pose the largest threat to production worldwide.

IMPACT/OUTCOME: ARS scientists in Madison, Wisconsin, and their university cooperators identified and characterized genes conferring genetic resistance to nematodes in carrots, and began breeding the resistant traits into standard carrot germplasm.

ACCOMPLISHMENTS: At present, herbicides are applied to control weeds prior to flooding rice fields. ARS researchers at Beaumont, Texas, have identified and characterized genes that accelerate seedling growth up to four times.

IMPACT/OUTCOME: When these genes are incorporated into standard germplasm, it may result in more

vigorous rice that will become established more quickly, thereby reducing the need for herbicide application.

continue studies using transgenic methods to incorporate antimicrobial disease resistant genes into crops (such as cottonseed) to protect pre- and postharvest seed products from microbial pathogens.

ACCOMPLISHMENTS: ARS scientists at New Orleans have inserted a bacterial (chloroperoxidase) gene into cotton, to enhance inhibitory activity against *A. flavus*, which produces aflatoxin contamination in crops. Additionally, the scientists have discovered a new family of proteins in corn kernels that are potential inhibitors of *A. flavus* growth.

IMPACT/OUTCOME: Experiments to inoculate bolls of the transgenic cotton with *A. flavus* and then assay for resistance will now be completed. Genes encoding the inhibitory proteins will be exploited by breeding selection and/or transgenic strategies in corn, cotton, and other crops.

continue studies to exploit natural antifungal resistance mechanisms in corn kernels for protection of the crop from pre- and postharvest attack by microbial pathogens.

ACCOMPLISHMENTS: The value of resistance to insect damage in reducing *Aspergillus flavus* infection aflatoxin contamination was assessed. Corn inbreds varying in insect resistance were evaluated for aflatoxin accumulation. Hybrids with resistance to southwestern corn borer and fall armyworm sustained less ear damage and less aflatoxin accumulation.

IMPACT/OUTCOME: Results suggest that combining genes for insect resistance and resistance to aflatoxin accumulation will be a productive strategy for developing new corn hybrids that are less vulnerable to aflatoxin accumulation.

identify QTLs affecting meat production and reproductive traits.

ACCOMPLISHMENTS: Quantitative trait loci (QTL) have been found in cattle and pigs. Three chromosomal regions have been identified that affect reproduction in cattle and nine chromosomal regions affecting reproduction in the pig. Four chromosomal regions have been identified to affect carcass composition in the pig and seven chromosomal regions have been identified to affect carcass composition and quality in cattle. The next step will be to identify the genes in these chromosomal regions to improve livestock production.

IMPACT/OUTCOME: The current process to identify these genes takes a long time and considerable resources. New laboratory resources are being developed to reduce the time and cost of this effort. DNA libraries were purchased to sequence a large number of genes and new DNA markers are being developed. Research efforts will also continue to identify additional chromosomal regions that affect reproduction and meat production traits. This research will improve genetic selection programs.

PERFORMANCE GOAL 2.1.3.2: Documented DNA base sequences of agricultural importance.
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Indicators:

During FY 2000, ARS will

decode more than 100,000 Expressed Sequence Tags (EST) in soybean in cooperation with partners. Genes express themselves by producing a message which can be cloned and decoded. The decoded message is called an EST. Discovering the function of these genes will make them useful for more effectively improving soybeans.

ACCOMPLISHMENTS: More than 80,000 gene sequences were characterized and 46 gene libraries created in FY 2000 in cooperation with scientists from several universities and industry.

IMPACT/OUTCOME: These sequences are being accessed by public and private researchers for research and development of economically important products, which may reach the marketplace in the next 5 to 10 years.

determine the nucleotide sequence of nearly the entire genome of a mustard plant (Arabidopsis), an important "model species" for understanding plant genomes in conjunction with university and private sector partners supported by ARS, the National Science Foundation, and Department of Energy. This also will provide substantial progress in sequencing the rice genome. Because the DNA sequence of many agronomically-important genes is similar among species, this knowledge may help to identify similar ones in major crops, thus accelerating the progress of crop improvement.

ACCOMPLISHMENTS: At the end of 2000, an international scientific team that included ARS researchers in Albany, California, finished the first essentially complete genome sequence for a plant, Arabidopsis, an experimental "model plant." It was sequenced first because of its small genome and rapid life cycle.

IMPACT/OUTCOME: Knowledge of the Arabidopsis genome is already helping to elucidate the structure and function of crop genomes and their constituent genes.

apply bioinformatic tools, biological databases, and information technology to more effectively improve crops, microbes, and beneficial insects.

ACCOMPLISHMENTS: With the ARS Center for Agricultural Bioinformatics at Cornell University, Ithaca, New York, serving as a hub, this ARS national program has expanded its institutional network for developing and maintaining crop genome databases and bioinformatics tools to encompass strong partnerships with the University of Minnesota, the University of California-Davis, and the Cold Spring Harbor Laboratory.

IMPACT/OUTCOME: At Ithaca, ARS scientists established a new worldwide web server to distribute genetic and genomic information for more than a dozen crops and model plant species as widely as possible to the scientific community.

ACCOMPLISHMENTS: ARS scientists and collaborators at Cornell University, Ithaca, New York, developed more efficient means for genetically mapping agriculturally-important traits. Often, mapping the genomic location of the genes that govern a trait serves as a vital prerequisite for genetic improvement of the trait. A new software tool was developed, MapPop, that enables high-quality genetic mapping with smaller-scale genetic studies.

IMPACT/OUTCOME: This new tool and approach may tangibly accelerate the generation of genetic data integral to the progress of crop genetic improvement.

ACCOMPLISHMENTS: The size and complexity of soybean's genome preclude it from being completely characterized in the near future. ARS scientists in Ames, Iowa, correlated information in the ARS soybean genome database with genomic data from the model plant Arabidopsis, the first plant genome to be completely sequenced.

IMPACT/OUTCOME: The arrangement of genes on the preceding two genomes was somewhat similar, indicating that information derived from the Arabidopsis genome may help accelerate genetic research and crop improvement in soybean, a major crop worldwide.

increase DNA markers on the poultry genetic map.

ACCOMPLISHMENTS: Additional DNA markers have been added to the poultry map and a complete description of the map is available on the web (<http://poultry.mph.msu.edu/>). The total number of markers exceeds 1,500 and 200 of these markers represent genes.

IMPACT/OUTCOME: The DNA markers are being used to identify chromosomal regions that affect susceptibility to Marek's disease. A gene that interacts with the virus has been identified as Growth Hormone and a certain form of this gene appears to make the chicken more resistant to the virus.

complete the DNA sequence of serotype 1 Marek's virus.

ACCOMPLISHMENTS: ARS scientists at East Lansing, Michigan, have sequenced 175,000 bases of DNA from a serotype 1 Marek's disease virus (MDV), thus providing a crucially important roadmap for understanding viral gene function as a first important step toward better diagnosis of MDV in commercial meat-type chickens. Molecular DNA sequencing of the serotype 1 MDV was transferred to academia and the poultry industry through a publication to enhance the global effort to elucidate the function of various viral genes and the epidemiology of MDV infection.

IMPACT/OUTCOME: The entire DNA sequence of the MDV will provide a crucial first step toward the development of novel molecular vaccines for MDV. Furthermore, the DNA sequence information of MDV will enhance understanding of the immunology of MDV infection that may prove useful to control other types of viruses important to the U.S. poultry industry.

carry out the molecular characterization of new isolates of Avian Leukosis J virus (ALV-J).

ACCOMPLISHMENTS: ARS scientists at East Lansing, Michigan, compared the DNA sequences of various isolates of avian leukosis virus subgroup J (ALV-J) and observed numerous mutations scattered throughout the genomes. These findings suggest that variations in these regions may alter the ability of the infected host to neutralize the virus and emphasize the importance of virus antigenic variants that may confound diagnosis and vaccine strategies for control of ALV-J virus infection.

IMPACT/OUTCOME: DNA sequence information from the ADOL-Hc1 virus strain, the U.S. prototype of ALV-J, and development of several recombinant baculovirus and fowlpox viruses containing the inserted ALV-J gene allowed the expression of recombinant ALV-J protein and the development of a sensitive assay for detection of ALV-J outbreaks in commercial meat-type chickens. Recombinant ALV-J viral antigen expressed in the baculovirus vector has been used in a commercial diagnostic kit for detection of antibody to ALV-J (U.S. Patent #6,146,641).

<p>PERFORMANCE GOAL 2.1.3.3: Release of improved germplasm, varieties, and breeds based on effective use of genetic resources.</p>

Indicators:

During FY 2000, ARS will

use genetic crosses and breeding methods to combine genes for mite and disease resistance into a single honey bee stock. After testing, the genetically resistant bee germplasm will be transferred to commercial queen breeders for use by beekeepers and the pollination industry for enhancing U.S. crop, fruit, and vegetable production.

ACCOMPLISHMENTS: The ARS Baton Rouge laboratory released Russian honey bees that showed resistance to mites from quarantine to the beekeeping industry, in cooperation with Bernard Apiaries in Breaux Bridge, Louisiana. The purpose is to begin to introduce mite-resistant stock into commercial honey bees.

IMPACT/OUTCOME: A new mite-resistant trait was discovered in a selected line of honey bees; the trait suppresses mite reproduction in the first offspring of a queen rather than (as previously) after a six-week delay. With this trait it may be possible to predict mite-resistance in a colony as soon as 17 days after a queen begins to lay eggs. This should greatly speed up breeding of resistance traits.

genetically improve crop, microbial, and beneficial insect varieties and strains that are less genetically vulnerable, which will enable producers and processors to maximize yields of high quality products, and minimize environmental degradation and production costs.

ACCOMPLISHMENTS: ARS researchers and university cooperators at East Lansing, Michigan, released a high-yielding, black seeded dry bean incorporating resistance to a variety of fungal diseases, including white mold, the most serious disease of the crop in the Great Lakes region.

IMPACT/OUTCOME: Cultivation of this bean may reduce fungicide use, while increasing profits for small producers who generally rely on good yields to offset profit risks.

ACCOMPLISHMENTS: The farmgate value of potatoes is worth several billions of dollars in the U.S., but cost of production is high because of diseases, pests, and suboptimal quality. ARS researchers at Prosser, Washington, and university cooperators in the Pacific Northwest released several superior potato varieties that should increase producer profitability.

IMPACT/OUTCOME: Bannock Russet and Gem Russet have improved disease resistance and yield. They are suitable for the French fry and fresh markets. Idarose is a superior red-skinned variety for boiling and salad purposes.

ACCOMPLISHMENTS: Two new woody ornamental landscape plants, a lilac and a redbud, were developed by researchers at Washington, D.C., and released to nurseries for propagation. The redbud is seedless, and the lilac is better adapted to warmer climates.

IMPACT/OUTCOME: Both new varieties can be propagated readily by standard techniques, and will furnish U.S. gardeners a wider diversity of well-adapted landscape plants.

ACCOMPLISHMENTS: Continued improvement in yield of soybeans is needed to enable U.S. farmers to maintain a competitive edge in world markets. In 1999 field trials, ARS researchers in Wooster, Ohio, found that a newly released semi-dwarf soybean cultivar topped the maximum yield trials at 97 bushels per acre.

IMPACT/OUTCOME: The results confirmed the potential of a well-managed subirrigation/drainage system, when used in combination with a high yield soybean cultivar, to produce consistent yields of 70 to 80 bushels per acre.

ACCOMPLISHMENTS: Peaches in the Southeastern U.S. are generally grown by small producers in relatively small volumes.

IMPACT/OUTCOME: The profitability of southeastern growers may be enhanced by 'Gulfprince' an early season peach with superior quality and shipping characteristics that was bred by ARS researchers and their university cooperators at Byron, Georgia.

ACCOMPLISHMENTS: Grain legumes are important rotational crops in cereal-based cropping systems of the U.S. Pacific Northwest. But many diseases, insect pests, and environmental stresses reduce seed yield and quality. ARS scientists in Pullman, Washington, released two new varieties of pea, two of lentils, and a new variety of chickpeas.

IMPACT/OUTCOME: These superior new varieties incorporate high yields and disease resistance.

ACCOMPLISHMENTS: Plum pox virus, the most serious virus disease of plums and other stone fruit, recently entered the U.S. and may threaten the U.S. stone fruit industry. ARS researchers at Kearneysville, West Virginia, genetically-engineered plums for resistance to that virus.

IMPACT/OUTCOME: These resistant varieties will provide producers with the means to combat that disease.

ACCOMPLISHMENTS: ARS researchers at Raleigh, North Carolina, developed soybeans with high concentrations of oleic acid, i.e., with highly unsaturated oil, using traditional breeding methods. Highly unsaturated oil is considered healthier than highly saturated oils.

IMPACT/OUTCOME: Such varieties bred by traditional approaches may enable U.S. farmers to remain competitive in exporting soybeans to nations that restrict use of transgenic crops.

ACCOMPLISHMENTS: Fusarium head blight (scab) has devastated the hard red spring wheat producing areas of the Northern Great Plains. ARS researchers and university cooperators at Fargo, North Dakota, released the scab-tolerant variety 'Alsen', which has high yields and greater scab resistance than current varieties.

IMPACT/OUTCOME: 'Alsen' wheat will likely be widely produced in regions previously devastated by scab.

ACCOMPLISHMENTS: The U.S. frying industry requires sunflower oil with 50-60 percent monosaturated fatty acid, which ideally is produced by a sunflower hybrid having high yield and superior agronomic properties. ARS researchers in Fargo, North Dakota developed a hybrid sunflower with the desired fatty acid profile, high yield, and disease resistance.

IMPACT/OUTCOME: The germplasm was released to private and public breeding programs for varietal development.

introduce a muscat flavored seedless white table grape bred to replace Italiz, a seeded muscat flavored table grape. This introduction is a specialty item in the U.S. and very desirable in Europe and South America where Italia is the number one table grape cultivar.

ACCOMPLISHMENTS: ARS scientists at Fresno, California, are releasing a new white seedless muscat table grape.

IMPACT/OUTCOME: A series of seedless cultivars ripening from early to late with white, red, or black skin color are needed to provide a continuous supply throughout the year for the consumer. A limited number of good seedless table grape cultivars are currently available to grape growers. The development of seedless grape varieties with naturally large size will reduce production costs and provide the type of grapes consumers want. ARS seedless table grapes have had a significant impact nationally such as 'Flame Seedless', the first ARS seedless grape released in 1973, which is now the second most important table grape grown in California, and "Crimson Seedless" which is the fourth leading variety.

release a blue/black seedless Concord flavored grape for farmers markets. This new grape provides a seedless type suitable for production in California where Concord grapes do not now grow well.

ACCOMPLISHMENTS: ARS scientists at Fresno, California, are releasing a new blue/black seedless Concord flavored grape.

IMPACT/OUTCOME: A series of seedless cultivars ripening from early to late with white, red, or black skin color are needed to provide a continuous supply throughout the year for the consumer. A limited number of good seedless table grape cultivars are currently available to grape growers. Since Concord type grapes are not readily cultivated in California, this new variety will allow for the production of a seedless Concord variety adapted to California conditions.

release new strawberry and blueberry germplasm with improved traits.

ACCOMPLISHMENTS: ARS scientists in Corvallis, Oregon, working jointly with Washington State University

released 'Puget Summer' strawberry, developed from a cross made by ARS in Corvallis. This new strawberry variety, in concert with recent releases of 'Firecracker' and 'Independence' by ARS in Corvallis, Oregon, provides three new late ripening cultivars for the Pacific Northwest. ARS scientists in Chatsworth, New Jersey, released 'Cara's Choice' and 'Hannah's Choice', two new highbush blueberry cultivars for the pick-your-own and home garden markets. ARS researchers in Poplarville, Mississippi, released 'Biloxi', an early, low chill highbush blueberry for the Gulf Coast Region.

IMPACT/OUTCOME: New strawberry cultivars released in the Pacific Northwest will extend what has been a fairly short season for the industry that has faced challenges in recent years, while depending primarily on high quality fruit for processing. Season extension has been a goal of breeding and production research in the Pacific Northwest strawberry industry. New blueberry varieties released by ARS in Chatsworth are high quality with advances in sweetness, firmness and flavor not available in commercial cultivars. These new varieties will increase public awareness of blueberry as a quality fruit and lead to greater consumption of blueberries as a healthful part of the diet. The new early, highbush blueberry from Poplarville will assist the expanding blueberry industry of the Gulf Coast Region to expand into new areas.

PERFORMANCE GOAL 2.1.3.4: Improve methods for identifying useful properties of plants, animals, and other organisms, and for manipulating the genes associated with these properties.

Indicators:

During FY 2000, ARS will

complete construction of a catfish genetic linkage map with at least 250 markers.

ACCOMPLISHMENTS: Scientists at the Catfish Genetics Research Unit, Stoneville, Mississippi, completed a catfish genetic linkage map with 264 markers.

IMPACT/OUTCOME: This map will be useful for selection of traits that are difficult to measure, such as disease resistance and fillet yield.

implement the "Test Day Model" for the genetic evaluation of the U.S. dairy herd.

ACCOMPLISHMENTS: The "Test Day Model" was put on hold until the Council on Dairy Cattle Breeding and the Cornell Research Foundation negotiate the use of a patent.

IMPACT/OUTCOME: Impact not measurable.

begin to combine novel technology (e.g., microarray or chip assays of gene activity) with conventional screens of standard agricultural traits (yield, adaptation, stress resistance) to identify coincident patterns of gene expression, occurrence of nucleic acids and proteins, and variation in the desirable agricultural traits. This information will help reveal the function of newly discovered genes so they can be manipulated and regulated in crops.

ACCOMPLISHMENTS: ARS scientists constructed a library of over 1,400 soybean genes that are expressed two days after infection by the soybean cyst nematode race 3. Over 1,000 of the genes were sequenced in an attempt to identify their function. In a complementary approach, DNA markers were developed which map a trait closely linked to soybean cyst nematode resistance.

IMPACT/OUTCOME: The library of genes will be applied to microchip DNA array technology, in which thousands of soybean genes can be monitored for their response to soybean cyst nematode invasion. This will allow researchers to identify genes that are involved in resistance to the soybean cyst nematode. Until these genes are positively identified, the use of new DNA markers can be used by breeders to develop

soybeans with improved resistance to this pest.

develop gene markers for coccidiosis which will lead to genetic strategies to control this poultry disease.

ACCOMPLISHMENTS: DNA markers have been found on chicken chromosome 1 that are associated with resistance to avian coccidiosis. The markers are currently being evaluated in industry populations. Additional research efforts are designed to identify the gene on chromosome 1 that influences resistance to coccidiosis and identify additional chromosomal regions that confer resistance.

IMPACT/OUTCOME: Avian coccidiosis cost the U.S. poultry industry more than \$700 million per year by reducing growth and feed efficiency in chickens. DNA markers will be used to select chickens that are less susceptible to coccidiosis and therefore decrease the number of chickens that will get sick. DNA markers will also be used to identify genes that influence resistance to coccidiosis and this information will be used to develop therapeutic agents.

expand understanding of genes of importance in food-borne bacterial pathogens, and develop high throughput sequencing of these genes. (Revised for clarity.)

ACCOMPLISHMENTS: ARS has focused on DNA sequencing as a practical tool to study problems such as: the effect of horizontal movement of genetic elements in the microbial environment; understanding the development of antibiotic or antimicrobial resistance, or resistance to stress and the development of increased virulence; or to phylogenetically characterize strains in order to develop better identification and differentiation methods. ARS studies genes that are present both on the bacterial chromosome and on DNA elements such as plasmids, transposons, integrons, and bacteriophages in order to achieve these goals.

IMPACT/OUTCOME: A better understanding of the genetic basis for resistance and adaptation of food-borne bacterial pathogens will help ensure the safety of the U.S. food supply.

produce large quantities of chicken and pig leptin and evaluate the biological function of this hormone in controlling feed intake.

ACCOMPLISHMENTS: Chicken and pig leptin have not been produced in the laboratory, but antibodies to chicken and pig leptin have been produced which allows researchers to quantify the amount of leptin in different animals and at different stages of growth, development, production, or nutrition.

IMPACT/OUTCOME: Future research will evaluate leptin's role in nutrient metabolism by using the antibody to leptin and other laboratory methodologies.

utilize mutants of pollen development to improve understanding of the signaling process that controls reproductive specificity. This knowledge is expected to lead to the development of processes that will enable geneticists to make much wider crosses than currently possible, which will result in a vast number of new genes becoming available for "conventional" breeding purposes.

ACCOMPLISHMENTS: ARS scientists developed one novel method for large scale screening of pollen mutants by pooling pollen from approximately 100 plants at a time. Numerous unexpected pollen mutant types were identified.

IMPACT/OUTCOME: The identification of pollen mutants will assist researchers in characterizing the individual signaling events that occur during successful pollen germination and fertilization. Knowledge about the genes that control these events can potentially be used in the future to facilitate pollination between distantly related species for the introduction of new genes by natural processes.

complete the process of transferring genes of the technology protection system into cotton in order to evaluate its value and biosafety.

ACCOMPLISHMENTS: The multiple genes of the Technology Protection System (TPS) have been assembled in cotton plants, but not all in the same plants. This awaits another round of crossing and selection of progeny that includes all of the genes in one plant.

IMPACT/OUTCOME: TPS has many potential applications, the most valuable of which is the ability to prevent the spread of genes from a genetically engineered crop to closely related wild plants. How to utilize the TPS genes properly is actively under discussion in many quarters.

continue to develop knowledge about the effect of spatial variability in soils on cotton fiber quality, and to determine how to manage fields to improve overall quality and reduce quality variability.

ACCOMPLISHMENTS: In two growing regions, fiber yield was found to be depressed in low areas of fields that had high soil moisture, soil phosphorus, and organic matter. Fiber maturity (a quality trait) was associated with high soil phosphorus.

IMPACT/OUTCOME: Designing “zoned” harvesting schemes to partially separate high-maturity from low-maturity fiber appears feasible from these data. The benefit is realized in the production of cotton bales of more uniform fiber quality, a high-priority need of cotton mills.

STRATEGY 2.1.4: Plant and animal biological processes: Develop biologically based technologies to improve productivity, safety, nutrient content, and quality of plants, animals, microbial organisms, and their products.

PERFORMANCE GOAL 2.1.4.1: Make technologies available for improving productivity, safety, quality, and the security of the agricultural production system.

Indicators:

During FY 2000, ARS will

develop a modified live vaccine for Edwardsiella tarda to prevent a significant blood borne bacterial disease of farm raised foodfish.

ACCOMPLISHMENTS: Scientists at the Aquatic Animal Health Research Unit, Auburn, Alabama, developed the vaccine Aquavac-ESC that was licensed to Intervet, who made it available to fish farmers for use during the 2000 growing season.

IMPACT/OUTCOME: Estimates indicate that 1 million doses of the vaccine will be sold in the year 2000.

compare marker vaccines for efficacy in protecting U.S. swine from swine fever.

ACCOMPLISHMENTS: Two vaccine trials were carried out to test the efficacy of 2 CSFV E2 subunit/marker vaccines and a live attenuated vaccine against a challenge with virulent CSFV. The live attenuated vaccine proved to be more efficient controlling CSFV in pigs than the subunit/marker vaccines when infection occurred shortly after vaccination.

IMPACT/OUTCOME: These data indicate that attenuated vaccine is an efficacious tool for use in the control of a CSF outbreak. Subunit/marker vaccines might be applied to herds not directly in contact with an outbreak, facilitating differentiation between vaccinated and naturally infected pigs, thus decreasing economic losses due to elimination of uninfected animals.

conduct molecular epidemiologic studies of the ecology of vesicular stomatitis virus (VSV) outbreaks in the Western Hemisphere.

ACCOMPLISHMENTS: In 1995, VSV-NJ caused outbreaks in Southwestern U.S. This was the first re-emergence of VSV-NJ since 1985. In 1997 and 1998 VSV-IN1 re-emerged in the Southwest after 30 years of absence. Using Reverse Transcriptase - Preliminary Chain Reaction (RT-PCR) DNA sequencing, and phylogenetic analyses combined with epidemiological information (molecular epidemiology), the determination was made that viruses causing the 1995, 1997, and 1998 VS outbreaks were newly introduced ones. They were more similar to viruses circulating in enzootic areas of Southern Mexico than to those causing previous outbreaks in the U.S.

IMPACT/OUTCOME: Rapid detection and characterization methodology for VSV by RT-PCR and direct sequencing is possible. Determining the origin of VSV strains causing outbreaks in the Western U.S. allows attention to be focused on analyzing the factors influencing the introduction of VSV into the U.S., such as environmental, climatological, and vectorial.

improve vaccine delivery systems for exotic poultry diseases, such as avian influenza.

ACCOMPLISHMENTS: Developed a vaccine using limited replication competent Venezuelan Equine Encephalitis virus vector containing an avian influenza H5 hemagglutinin gene insert.

IMPACT/OUTCOME: The vaccine vector induced protective immunity in chickens against a highly pathogenic H5 avian influenza virus when given subcutaneously. Since poultry does not have immunity against this vector, the vaccine has the potential for widespread use.

develop a DNA sequence database and diagnostic tools for avian leukosis J virus (ALV-J).

ACCOMPLISHMENTS: DNA was sequenced and nine strains of ALV-J compared from different U.S. poultry flocks isolated in the years 1993 to 1997. Analysis clearly shows that the ALV-J viruses in the U.S. are changing over time. It also suggests that U.S. strains may have evolved independently from the ALV-J viruses in Great Britain. DNA sequencing efforts made it possible to design PCR primers for use in quickly detecting the ALV-J virus in infected birds.

IMPACT/OUTCOME: There are two commercial diagnostic kits for ALV-J on the market. Unfortunately, both of them detect only a subset of the ALV-J field strains, generating both false negative and false positive results. DNA sequencing demonstrated that ALV-J's are highly variable and explains why the existing commercial kits are unsatisfactory. Vaccine developers and diagnostic kit designers need to target the portions of ALV-J that are constant and not likely to change. The PCR primers were designed to bind to highly conserved regions of the ALV-J genome. Consequently, several poultry breeding companies are using the primers and PCR conditions to aid them in detecting ALV-J positive chicks.

enhance control of transmissible spongiform encephalopathies (TSE) through use of preclinical diagnosis.

ACCOMPLISHMENTS: Through collaborative research with the National Animal Disease Center, Ames, Iowa, Washington State University, APHIS, MAFF (United Kingdom), and Utah State University (Logan, Utah), the stage 2 OIE (Office of International Epizootics – Assay development and standardization) validation of the third eyelid test was completed and published. The third eyelid test for sheep scrapie is the first and only practical preclinical diagnostic test for a transmissible spongiform encephalopathy worldwide.

IMPACT/OUTCOME: This work represents the next step toward international acceptance of the test. It is being implemented as part of the U.S. national scrapie test validation and eradication program.

develop control strategies for porcine viruses that cause reproductive losses.

ACCOMPLISHMENTS: A vaccine developed by ARS scientists and subsequently evaluated by them and a commercial cooperator was found to be effective and is in the final stages of Federal licensure. Also, a highly sensitive diagnostic test was developed for porcine reproductive and respiratory syndrome (PRRS)

during the past year using a powerful molecular technique based on detecting a portion of the nucleic acid core of the PRRS virus.

IMPACT/OUTCOME: Use of the vaccine, which is expected to be marketed later this year, will reduce the clinical impact of PRRS on the U.S. swine industry. In addition, the use of the diagnostic test will allow the early and definitive recognition of epidemics of PRRS and immediate implementation of control strategies to minimize further spread and clinical impacts of the disease.

develop knowledge of the life cycle of Neospora, the major cause of abortion in cattle that can be used as a management strategy to lower the incidence of abortions in cattle.

ACCOMPLISHMENTS: ARS scientists have achieved complete protection against congenital neosporosis in the mouse model by immunization of dams with *Neospora caninum* antigen prior to mating and subsequent challenge with the parasite. It was determined that this antigen was associated with an insoluble portion of the *N. caninum* extracts as a first step in purifying the protective component.

IMPACT/OUTCOME: Abortions due to *Neospora caninum* have a major impact on the dairy and beef cattle industries throughout the world. Knowledge about transmission of this parasite will help producers manage and prevent the disease.

continue to clone and sequence genes that promote degreening of maturing canola seeds. Identify the genes, if possible, and characterize their mode of action, then begin transferring the genes into canola for evaluation.

ACCOMPLISHMENTS: ARS scientists identified the period during seed development when a key enzyme for degreening of seed chlorophyll is the most active.

IMPACT/OUTCOME: Knowledge of the period of highest activity of the degreening enzyme will facilitate purification of the enzyme and cloning of the degreening gene, which is necessary for characterizing how the gene works and, finally, for transferring it into canola for evaluation.

begin evaluation and testing of cottonseed that carries the technology protection system.

ACCOMPLISHMENTS: See Performance Goal 2.1.3.4. Since the elements of the Technology Protection System are not yet assembled into a single plant, and this evaluation could not go forward.

evaluate the determinants of in-field variation of cotton fiber quality. Begin to analyze the data in a way that will make predictions of fiber quality variability possible.

ACCOMPLISHMENTS: In fields with early and late planting dates, boll distribution on the plants was found to be a major contributor to fiber length variability, but not maturity variability. In years with ample mid-season moisture, early planting increased yield and fiber length and maturity.

IMPACT/OUTCOME: The data are useful for the modeling (prediction) of fiber quality, which will help cotton mills (users of the fiber) to select the appropriate quality for various spinning processes which have differing needs for raw material inputs.

determine factors that regulate u-calpain activity in postmortem muscle and develop strategies to control variation in meat tenderness.

ACCOMPLISHMENTS: The bovine and ovine u-calpain genes were cloned and placed on the genetic linkage map. DNA markers near the u-calpain gene were used to evaluate u-calpain's potential effect on meat tenderness. A number of proteases were identified to degrade calpastatin; however, only u-calpain and m-calpain degraded calpastatin in the same manner as during postmortem aging. ARS scientists determined that, under physiological conditions, the rate of proteolysis was reduced, but not completely halted, by

increasing the ratio of calpastatin:u-calpain from 2:1 to 4:1.

IMPACT/OUTCOME: These results will lead to a greater understanding and control of biological mechanisms that regulate variation in muscle growth and meat tenderness. ARS scientists determined that variation in muscle shortening, proteolysis of muscle proteins during aging, and connective tissue accounts for 72 percent of the variation in pork tenderness. They also determined that muscle shortening affects meat tenderness, but altering proteolysis of muscle proteins does not.

develop national and international surveillance and diagnostic programs using the ARS sheep scrapie test.

ACCOMPLISHMENTS: A protocol has been developed with APHIS to complete stage 3 OIE validation (determination of assay performance characteristics) of the third eyelid test.

IMPACT/OUTCOME: These data will provide statistically significant test performance characteristics for the third eyelid test. In addition to aiding in scrapie eradication from the U.S., these data will make the test acceptable internationally for continued quality assurance programs in the U.S. once scrapie is eradicated. Due to the enormous economic impact of transmissible spongiform encephalopathies (TSEs), such as bovine spongiform encephalopathy (mad cow disease), the importance of the eradication of related TSEs, such as scrapie, from the U.S. is clear. The final impact/outcome is improved export advantages for U.S. animal agriculture.

study the effects of stress on neonatal pigs and their ability to respond to stress during early development.

ACCOMPLISHMENTS: Scientist at the Animal Physiology Unit, Columbia, Missouri, in collaboration with scientists at the University of Missouri demonstrated that plasma protein in weanling diets provided protection to infectious disease.

IMPACT/OUTCOME: The research was recognized by NPPC with the 2000 Innovation Award for basic research.

develop molecular markers to distinguish Karnal bunt from similar fungi.

ACCOMPLISHMENTS: Based on DNA sequence data, five sets of polymerase chain reaction (PCR) primers were developed that were specific for the Karnal bunt fungus, *Tilletia indica*, and three sets were designed specific to *Tilletia walkeri*, a closely related fungal species of ryegrass that had been indistinguishable previously. Later these tests were used to show that a shipload of wheat exported to the European Union was contaminated with low levels of the ryegrass pathogen, not Karnal bunt, so that negative regulatory action was avoided.

IMPACT/OUTCOME: These tests provide rapid, accurate identification of Karnal bunt contamination in grain, and, equally important, to accurately determine that suspected fungi may be Karnal bunt. This capability will allow international wheat trade to proceed with fewer shipments rejected because of incomplete or mistaken identifications of the fungi.

determine what substances when added to the diet of dairy cattle will effectively reduce the pH of their blood to prevent milk fever.

ACCOMPLISHMENTS: ARS scientists at Ames, Iowa, fed various sources of chloride and sulfate containing chemicals to dry nonpregnant dairy cows and demonstrated that chloride consistently counteracted the effects of dietary potassium that causes a decrease in blood acidity, thus contributing to hypocalcemia (milk fever). Furthermore, this study found that chloride was more effective than sulfate in the prevention of milk fever in peri-parturient cows.

IMPACT/OUTCOME: This new information has resulted in the development of hydrochloric acid treatment

of feeds by at least two companies (West Central Corp., Ralston, Iowa, and Nutritech, Abbotsford, British Columbia) and allowed farmers, veterinarians, and nutritionists to more accurately choose the most effective feeds and chloride sources for balancing transition dairy cow rations.

demonstrate that parathyroid hormone is not properly taken up by cell receptors when dietary potassium is elevated and that the mechanism is due to elevation of blood pH by dietary potassium.

ACCOMPLISHMENTS: ARS researchers at Ames, Iowa, have demonstrated that mild alkalosis can attenuate the action of parathyroid hormone at its target organs (bone and kidney), resulting in decreased production of the active form of vitamin D, bone calcium and phosphorus reabsorption. Collectively, these effects lead to the inability of dairy cows to respond to the high demand for calcium at parturition and ultimate development of peri-parturient hypocalcemia (milk fever).

IMPACT/OUTCOME: This research has provided a more detailed understanding of the pathogenesis of milk fever. The research has also emphasized the importance of dietary methods for reversing alkalosis in order to re-establish target tissue sensitivity to the parathyroid hormone and prevent clinical and sub-clinical hypocalcemia in dairy cows. An enhanced understanding of the effects of dietary factors on the overall health of young and adult dairy cattle will benefit the U.S. producer and consumer.

OBJECTIVE 2.2: Safe food: "Maintain a ... safe supply of food to meet human ... needs"

STRATEGY 2.2.1: Plant and animal product safety: Provide knowledge and means for production, storage, and processing of safe plant and animal products.

PERFORMANCE GOAL 2.2.1.1: Transfer knowledge developed by ARS to industry and regulatory agencies.

Indicators:

During FY 2000, ARS will

complete the development and transfer of information to regulatory agencies, such as APHIS Veterinary Service and FSIS, describing methods for on farm management of pigs to achieve a preharvest parasite free certification program to assure pork product safety.

ACCOMPLISHMENTS: A preharvest certification program for *Trichinella* is needed to assure consumers that the pork they buy and bring into their homes is free of this parasite. ARS scientists, together with the pork industry, developed the certification system based on the knowledge of risk factors, detection methods, and good management practices. Certification requires pork producers to meet certain management criteria that eliminate risk of exposure of pigs to the *Trichinella* parasite.

IMPACT/OUTCOME: This certification program has been adopted by the pork industry, and APHIS and FSIS are currently developing regulations for management of the program. Certification should also help the USDA establish equivalency agreements with foreign markets regarding the safety of U.S. pork.

develop a profile of pathogens present in biofilms on processing equipment. This information will be used to develop methods to reduce the presence of pathogens in biofilms on equipment in poultry processing plants.

ACCOMPLISHMENTS: Unfortunately, this Indicator was not achieved; due in part to the retirement of a scientist critical to the research; the restructuring of the project into two separate ones, and refocusing of the scientist working on the biofilm work to research more associated with intervention strategies.

IMPACT/OUTCOME: An understanding of the microbial ecology of biofilm communities associated with

poultry products continues to be of significance to the Food Safety National Program, because of its importance with respect to pathogenicity and food quality. Thus, research in this area will continue, albeit at a slower pace than previously envisaged. Expectation is that the Indicator will require at least another 3 years to be achieved.

develop techniques to improve the effectiveness of experimental and commercial sanitizers to further reduce pathogen levels in fresh fruits and vegetables and minimally processed products from them.

ACCOMPLISHMENTS: ARS has made several significant advancements in this area. Research has shown that some chemicals used for sanitizing seeds for sprouting are ineffective against the bacteria and/or they damage the seeds leading to a reduction in sprouting. Treatment of seed for 10 minutes with calcium hypochlorite providing 20,000 ppm of free chlorine was highly effective in reducing specific pathogens. Irradiation studies indicate however, that seeds irradiated to 2kGy can inactivate > 99 percent of pathogens without significantly affecting yield, and extend shelf-life of sprouts themselves. Gas-phase application of chlorine dioxide showed significant promise for general use by the produce and seeds industry. ARS studies also showed how to increase the efficiency of hydrogen peroxide treatment for removing attached pathogens from apples. Reductions of > 99.99 percent could be readily obtained.

IMPACT/OUTCOME: Information on the efficacy and efficiency of conventional and experimental methods to decontaminate seeds and produce was conveyed to growers, packers, processors, and the FDA. The research has helped meet the goals established by the FDA for several commodities; for example, a 99.999 percent (5 log) reduction target for unpasteurized apple cider, providing the new treatments can be translated into approved and affordable technology.

*provide the research information necessary to obtain an Experimental Use Permit from EPA for use of competitive strains of *Aspergillus flavus* and *Aspergillus parasiticus* to control preharvest aflatoxin contamination of peanuts.*

ACCOMPLISHMENTS: ARS has developed the information that is necessary to obtain an experimental use permit for testing a product utilizing competitive strains of *A. flavus* and *A. parasiticus* to prevent contamination of peanuts with aflatoxin.

IMPACT/OUTCOME: A Georgia company is interested in the technology and is moving forward with efforts to license the technology from ARS. An experimental use permit will allow the product to be field tested in more than 10 acres of peanuts per season in order to determine if it will effectively exclude toxin producing fungi from peanuts grown under commercial conditions, and keep the aflatoxin content under the tolerance required by European markets.

*provide the research information necessary to expand provisions of the Experimental Use Permit from EPA for use of a competitive strain of *Aspergillus flavus* to allow treatment of 20,000 or more acres of cotton to control preharvest aflatoxin contamination of cottonseed.*

ACCOMPLISHMENTS: Aflatoxins are extremely toxic substances produced by some strains of *Aspergillus flavus* and most strains of *Aspergillus parasiticus*. These fungi are ubiquitous and infect many crops including peanuts, corn, cottonseed, and tree nuts, and even some wild plants growing in noncultivated areas. Both the health risks and the reduced profitability of contaminated crops create a need to prevent the formation of aflatoxins. Strains of *A. flavus* which do not produce aflatoxin may be used to competitively exclude the toxin producing strains prior to boll development. ARS developed the information necessary for EPA to allow the treatment of up to 20,000 acres of cotton to further assess and confirm the value of this product in preventing aflatoxin in cottonseed in a wide variety of environmental conditions and production practices.

IMPACT/OUTCOME: Use of this product to prevent aflatoxin in cottonseed will help assure its safety for animal feed purposes, in particular cottonseed in dairy cattle feed, and will help to maintain the continued profitability of the crop.

expand the capabilities of the multiplex PCR which was developed to specifically detect and identify E. coli O157:H7 in foods. The expanded assay will allow identification of the type of Shiga toxin (Stx1 or Stx2) produced and will make it possible to determine the presence of the H7 antigen (fliCgene which encodes the H7 flagellat antigen). An assay with these capabilities will be useful to the FSIS.

ACCOMPLISHMENTS: A method involving a multiplex polymerase chain reaction (PCR) assay was developed to simplify detection and identification of *Escherichia coli* O157:H7 in foods, and to also permit detection of low levels of bacteria subjected to cold stress. Primers for a plasmid-encoded hemolysin gene (*hly₉₃₃*), and chromosomal flagella (*fliC_{H7}*; flagellar structural gene of H7 serogroup), Shiga toxins (*stx₁*, *stx₂*), and attaching and effacing (*eaeA*) genes were used in a multiplex PCR for co-amplification of the corresponding DNA sequences from *E. coli* O157:H7. Sensitivity of the assay was #1 CFU/g of food including ground beef and bovine feces: results could be obtained within 24 h.

IMPACT/OUTCOME: In addition to allowing for rapid detection and identification of low numbers of *E. coli* O157:H7 in foods and other types of samples, the multiplex PCR can markedly reduce the time required for confirmation of isolated colonies since lengthy biochemical, serological, and toxin testing could justifiably be eliminated. This technology can enhance the ability of regulatory agencies and industry in testing for *E. coli* O157:H7.

develop a monoclonal antibody-based method for concentrating and identifying Campylobacter jejuni and E. coli in food washes in collaboration with an industry partner. The same reagents will be used to aid in characterizing how C. jejuni attaches to chicken surfaces.

ACCOMPLISHMENTS: ARS has developed a MicroFiltration assay (MFA) for Campylobacter using europium-labeled monoclonal antibodies, and two alternative immunomagnetic beads for the direct detection of *C. jejuni*. Several new approaches for detecting *E. coli* O157:H7 have been developed, a 96-well microplate method, a light addressable potentiometric sensor method using streptavidin coated magnetic beads, a time-resolved fluorescence assay using europium, and an immunomagnetic electro-chemiluminescent method.

IMPACT/OUTCOME: These methods represent a new approach to extracting, concentrating, and isolating bacterial pathogens directly from foods. Sensitivities of 10 bacteria per ml using a single antibody or mixture of antibodies can be directly achieved and with inclusion of an enrichment step, sensitivity to 1 bacteria per gram food. These technologies will be directly transferred to regulatory agencies for evaluation and inclusion in their protocols.

demonstrate the safety of the Brucella abortus RB51 strain in nontarget animal species as a step prior to initiation of a vaccination program of bison and elk within Yellowstone National Park and surrounding areas.

ACCOMPLISHMENTS: ARS scientists at Ames, Iowa, in collaborative studies with scientists in APHIS and the Wyoming Fish and Game Department, evaluated the clinical effects and immune responses against the *Brucella abortus* RB51 vaccine strain in various representative nontarget species of the Greater Yellowstone Area (deer mice, ravens, ground squirrels, coyote, moose, pronghorn, bighorn sheep, and mule deer). The scientists demonstrated that strain RB51 can elicit host immune responses and is safe in these nontarget species. Ongoing studies are evaluating the safety of the RB51 vaccine in pregnant black bears as a model for the endangered grizzly bear.

IMPACT/OUTCOME: These studies provided novel information on the clinical safety and effectiveness of the *Brucella abortus* strain RB51 vaccine for nontarget species in the Greater Yellowstone Area, thus allowing the vaccine to be used to reduce *Brucella* infections in free-range elk and bison populations to reduce the risk of transmission from wildlife animals to domestic cattle.

determine whether ballistic delivery of strain RB51 vaccine is a viable and efficacious method of vaccine delivery for bison.

ACCOMPLISHMENTS: ARS researchers at Ames, Iowa, demonstrated that hand vaccination of bison calves with *Brucella abortus* RB51 strain vaccine significantly enhanced protection against brucellosis. In contrast, ballistic vaccination of bison calves was less effective than hand vaccination. ARS scientists at Ames, Iowa, also showed that the RB51 vaccine was safe for deer mice, ravens, ground squirrels, coyoted moose, pronghorn, bighorn sheep, and mule deer. Some of these nontarget species developed immunity, but no clinical signs of disease.

IMPACT/OUTCOME: These studies provided important background information necessary for initiation of a vaccination program for wild bison and elk within Yellowstone National Park and surrounding areas. The finding of superior effectiveness of hand delivery over ballistic administration for vaccination against brucellosis in wildlife provides important knowledge for future development of optimum vaccination strategy against brucellosis in those areas. Further evaluation of the efficacy of *Brucella abortus* RB51 vaccine delivery methods to wildlife will enhance its practical utilization in the field. Demonstration of the clinical safety and efficacy of the *Brucella abortus* RB51 vaccine, as shown by studies conducted in collaboration with scientists from ARS at Ames, Iowa, and APHIS, will enhance the feasibility of developing a vaccination program for free-range bison.

determine the efficacy of a new bovine leptospirosis vaccine for use in the U.S.

ACCOMPLISHMENTS: ARS scientists at Ames, Iowa, evaluated new vaccines for bovine leptospirosis in collaboration with two industrial partners. In the first project, now nearing completion, vaccines designed by Pfizer Corp. were evaluated for their ability to prevent urinary shedding of virulent *Leptospira* after live challenge. Data from these studies are still being collected. In the second series of vaccine studies, ARS researchers working on the Spirochete Diseases project in collaboration with a scientist at CSL (Australia) evaluated a novel vaccine formulation against bovine leptospirosis. Results from the first phase of these studies suggested that the vaccine prevents urinary shedding of *Leptospira* in animals challenged with the live virulent hardjo serovar. In the current phase of these studies, ARS scientists are evaluating whether the CSL vaccine is capable of protecting against reproductive failure (abortion, birth of weak offspring) in pregnant cows.

IMPACT/OUTCOME: Although the initial results are promising, further studies are necessary to address important issues relating to the feasibility of this vaccine to prevent *Leptospira* infection and colonization of the kidney by the hardjo serovar. Yet to be determined is whether this vaccine is capable of protecting against other species of serovar hardjo (3 different species share this designation) as well as other genotypes. Because all current vaccine formulations are serovar specific and provide minimal protective immunity against other antigenic types of *Leptospira*, future studies are planned to identify cross-protective antigens for second-generation vaccines that will prevent urinary shedding and infection by these additional serovar types.

determine the role of a newly recognized virus in the etiology of poult enteritis and mortality syndrome in turkeys.

ACCOMPLISHMENTS: ARS scientists at Athens, Georgia, identified a novel strain of astrovirus isolated from the thymus of Poult Enteritis Mortality Syndrome (PEMS) infected turkeys and sequenced the entire genome of a nonhuman strain of astrovirus. ARS researchers then verified that this purified astrovirus caused PEMS-like disease in naive turkey poults as characterized by growth depression, mortality, enteritis and immunosuppression. A new diagnostic test, RT-PCR, was developed to identify conserved and divergent regions of the astrovirus genome and this test kit detected astrovirus in commercial turkey flocks.

IMPACT/OUTCOME: These studies indicate an important role of the new astrovirus in PEMS-associated pathology in turkeys. The RT-PCR test was transferred to scientists at Virginia Polytechnical Institute and Texas Veterinary Medical Diagnostic Laboratory and is currently being used to detect astrovirus in commercial flocks. This test will provide new ways to understand the pathogenesis of astrovirus infection (and PEMS infection) that will ultimately increase basic knowledge on the interactions between the turkey immune system and virus infections and enable the development of a vaccine against turkey PEMS.

GOAL III: A Healthy and Well-Nourished Population Who Have Knowledge, Desire, and Means to Make Health Promoting Choices.

Analysis of Results: This goal is the focus of much of ARS' research related to human nutrition and health. Under Goal III, 7 Indicators are aligned under 3 Performance Goals. Because of the unique and dynamic nature of research, several Indicators were added to the Report that did not first appear in the Annual Performance Plan for FY 2000. This was done to ensure that significant accomplishments that were not anticipated last year were reported. While it is not possible to report research accomplishments numerically, the progress projected in all 7 Indicators were completed or substantially completed during FY 2000.

OBJECTIVE 3.1: Nutritious food: "Maintain an adequate and nutritious ... supply of food to meet human nutritional needs and requirements."

STRATEGY 3.1.1: Human nutrition requirements: Determine requirements for nutrients and other food components of children, pregnant and lactating women, adults, and elderly of diverse racial and ethnic backgrounds.

PERFORMANCE GOAL 3.1.1.1: Indicators of function determined and related to diet and health.

Indicators:

During FY 2000, ARS will

conduct human feeding studies to determine the effects of soy protein in reducing risk factors for heart disease and cancer. The results will help determine if inclusion of soy protein in the diet has beneficial effects on chronic disease occurrence.

ACCOMPLISHMENTS: Research on rats showed that 25-50 percent of chemically induced breast cancer can be prevented by soy protein isolate, which is used in virtually all the soy-based infant formula in the U.S.

IMPACT/OUTCOME: A human feeding study was not conducted since Institutional Review Board (IRB) approval was delayed.

expand the understanding of changing needs for nutrients that occurs throughout the life cycle. Studies will be conducted to determine the relationship between diet and bone health, cognitive and neurological development, and the factors such as energy intake and energy expenditure that lead to obesity in children.

ACCOMPLISHMENTS: A number of projects were completed that address these topics.

Elementary children and junior high school children who were undernourished at a younger age had slower reaction (decision) times and differences in neurophysiology of specific brain areas.

-Determined that body size and behavioral traits play a role in the ability of women to accurately self-report energy intake.

-Found that obesity may not be a protective factor against bone loss for obese women because it is thought that obese individuals are at less risk of developing osteoporosis due to increased weight load on the skeleton.

-Demonstrated that boron has a role in the earliest stages of bone formation in mammals; data suggests that boron may be important in embryo development in humans and supports the concept that boron is an essential nutrient for humans.

-Found the first evidence that zinc status is predictive of mood disturbances and behavior problems in school-aged children.

- Showed that vitamin B12 deficiency is associated with cognitive and behavioral impairment in children, which is also seen in the elderly.
- A study conducted to determine whether gains in bone mineral density induced by calcium and vitamin D supplementation persisted after supplementation was discontinued in elderly men and women showed that the benefits were lost over 2 years after 3 years of supplementation.
- Postmenopausal women require dietary intakes of vitamin K in amounts that exceed the current recommended intakes to restore function of vitamin K in bone.
- Demonstrated that there are differences in parameters that measure cognitive function between cultivated- or wild blueberry-supplemented rats.
- Established contemporary reference standards for body composition for European-, African-, and Mexican-American children; these data serve as the standards for defining obesity in children.

IMPACT/OUTCOME: Findings from these studies add to the body of knowledge on the role that nutrition has in maintaining and improving health. Many of these findings result in scientific recommendations which may lead to changes in dietary recommendations and nutrition policy which affect food assistance programs.

STRATEGY 3.1.2: Food composition and consumption: Develop techniques for determining food composition, maintain national food composition databases, monitor the food and nutrient consumption of the U.S. population, and develop and transfer effective nutrition intervention strategies.

PERFORMANCE GOAL 3.1.2.1: Transfer new measurement techniques and data to users, release results of surveys, and disseminate effective nutrition intervention strategies.

Indicators:

During FY 2000, ARS will

conduct a study of the validity of 24-hour recall questionnaires conducted both in person and by telephone. Although the costly in-person interview to obtain dietary information is assumed to be the most accurate indicator of dietary consumption, this will be the first test of its validity and comparison made with less costly telephone interviews.

ACCOMPLISHMENTS: The new method using a multiple-pass method was tested in a national random digit dial sample.

IMPACT/OUTCOME: Both quantitative and qualitative data from the study demonstrated that the new multiple-pass method was an effective way to collect a complete 24-hour dietary recall by telephone.

work with the National Center for Health Statistics to combine the dietary portions of the USDA's Continuing Survey of Food Intakes with DHHS' National Health and Nutrition Examination Survey. This will eliminate duplication, reduce costs, and allow for the first time linkage of data on food intake with parameters of health status.

ACCOMPLISHMENTS: Leadership of HHS and USDA have identified a more comprehensive integration of these two surveys as a major priority. Staff members have been engaged in intensive discussions and have arrived at a basic approach. The process of integration has involved input from users of the data.

IMPACT/OUTCOME: Proven and now fully-automated methods of data collection will be used, the needs of customers and stakeholders will continue to be met, and data will be released in a timely fashion. Some issues still remain which are being addressed.

develop accurate procedures for the measurement of flavonoids in foods. The importance of flavonoids as antioxidants in the diet is of increasing interest as is the ability to identify them from various plant sources.

ACCOMPLISHMENTS: Food extraction systems were developed which permit quantitative removal of all classes of flavonoids from foods.

IMPACT/OUTCOME: These extraction systems, coupled with the HPLC system which was developed last year, will greatly increase the speed and decrease the cost of generating data on the flavonoid content of foods. These data will be incorporated in the U.S. National Nutrient Databank.

STRATEGY 3.1.3: Nutritious plant and animal products: Develop more nutritious plant and animal products for human consumption.

PERFORMANCE GOAL 3.1.3.1: Demonstrate improved nutritional quality.
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Indicators:

During FY 2000, ARS will

determine the bioavailability of specific food carotenoids and their response in plasma tissue. Since nutrient bioavailability can differ between plant species, it is important to know which ones contain the most available nutrients.

ACCOMPLISHMENTS: Demonstrated that carotenoids can be intrinsically labeled with carbon 13 in food (kale).

IMPACT/OUTCOME: The label can be detected in human plasma.

determine which plant varieties have increased mineral content with potential beneficial effects on human health. Identification of plant varieties with potentially increased nutrient content can greatly affect dietary recommendations and aid at-risk populations.

ACCOMPLISHMENTS: In a greenhouse study, 16 genotypes of Brassicas (broccoli) were screened for their ability to accumulate selenium from treated growth media. Results indicate that there is significant genetic potential within the Brassica genomes to select for species that accumulate more selenium in their edible portions.

IMPACTS/OUTCOME: Work is continuing on a project to increase the density of iron and zinc in edible portions of five staple food crops comprising maize, rice, wheat, beans and cassava.

GOAL IV: To Enhance the Quality of the Environment Through Better Understanding of and Building on Agriculture's and Forestry's Complex Links with Soil, Water, Air, and Biotic Resources.

Analysis of Results: This goal is the focus of much of ARS' research on a wide range of environmental issues related to agriculture. Under Goal IV, 42 Indicators are aligned under 12 Performance Goals. Because of the unique and dynamic nature of research, several Indicators were added to the Report that did not first appear in the Annual Performance Plan for FY 2000. This was done to ensure that significant accomplishments that were not anticipated last year were reported. While it is not possible to report research accomplishments numerically, the progress projected in 42 Indicators was completed or substantially completed during FY 2000.

OBJECTIVE 4.1: Balance agriculture and the environment: "Increase the long-term productivity of the U.S. agriculture and food industry while maintaining and enhancing the natural resource base on which rural America and the U.S. agricultural economy depend."

STRATEGY 4.1.1: Natural resource quality: Develop new concepts, technologies, and management practices that will enhance the quality, productivity, and sustainability of the Nation's soil, water, and air resources.

PERFORMANCE GOAL 4.1.1.1: Demonstrate concepts and on-farm agricultural technologies and management practices that maintain and enhance the environment and natural resource base.

Indicators:

During FY 2000, ARS will

provide multi-year results on the feasibility and cost effectiveness of converting from intensive tillage systems to environmentally enhancing direct seeding crop management systems. This information will contribute to establishing sustainable agroecosystems in the Pacific Northwest.

ACCOMPLISHMENTS: ARS is a partner in a multi-state, multi-institution project that focuses on direct seeding through mulch and standing stubble in unplowed fields. The partnership holds farmer meetings and produces fact sheets, how-to sheets, case studies of operating farms, etc. On the basis of long-term plots, ARS has shown that an early effect of direct seeding is to increase soil compaction (110 percent above that of conventional tillage), but that over time, this effect becomes much reduced (20 percent above conventional tillage after 17 years). A major problem with planting through heavy mulch is that of placing the seed properly to avoid poor stands. In 2000, ARS applied for a patent for a direct-seeding attachment that has been found to increase stand counts from 9 to 53 percent, depending on crop species, soil conditions and amount of crop residue. ARS is also currently researching the suitability of different crops to complement wheat production in direct seed systems.

IMPACT/OUTCOME: There are no firm data on the adoption rate of direct seeding in the Eastern Washington/Oregon area, but there is anecdotal evidence of considerable interest among producers in that region. At a recent meeting on the subject of air quality, publications were made available citing the direct seed experiences of about a dozen farm families. Four years ago, an equipment dealer in Northeast Oregon struggled to sell one direct-seed drill model while today, seven different drills are available. A newly developed drill attachment to plant seeds in conservation tillage systems has recently been announced. National and international machinery production companies have contacted ARS about it, and there are daily calls from other interested parties, including farmers.

finalize the development of methods using flocculants to reduce the transport of weed seeds, microbes, and pathogens in water. This technology will lessen the risks of environmental contamination and ecosystem impacts from chemicals. This information will be shared with NRCS, canal companies, farmers, consultants, and other water users and providers.

ACCOMPLISHMENTS: Scientists at Kimberly, Idaho, showed that applying polyacrylamide (PAM) through this irrigation water after cattle, fish, or swine manures were applied to the soil decreased the number of microorganisms in the runoff water by 99 percent compared to the furrow irrigation practice where no PAM was added.

IMPACT/OUTCOME: The finding suggests that applying PAM into the irrigation water at 10 parts per million not only reduces soil erosion, but can reduce total fecal coliform and bacteria in both the soil and groundwater where manure is being applied to the land from animal feeding operations and aquaculture production systems.

develop cropping systems, rotations and residue management practices to enhance soil quality, while reducing fertilizer and agrochemical inputs.

ACCOMPLISHMENTS: Researchers at Florence, South Carolina demonstrated that site-specific fertilizer recommendations should be based on direct management of soil response, rather than estimates of soil variability.

IMPACT/OUTCOME: Despite the promise of variable-rate fertilizer and water applications through irrigation systems, it has been difficult to recommend precision irrigation on site-specific management because of limitations in the understanding of soil variability. These results show that improved measurements of soil variability will provide an increased ability to apply more accurately different amounts of fertilizer and water under irrigated agriculture.

ACCOMPLISHMENTS: At Temple, Texas, researchers found that two-pass systems allow the use of conventional planters without special attachments, ballasting, etc., for adequate crop establishment and growth, making low-risk conservation tillage workable and manageable for row crops on high-clay soils. A Mandan, North Dakota, research team determined the influences of previous crop and crop residue on crop production and soil quality in no-till cropping systems. Crop production was reduced by up to 50 percent when 2 consecutive years of the same crop were grown compared to 2 years with a different crop. Scientists in Akron, Colorado, showed that legumes, corn and sunflower can be grown in the central Great Plains region, thereby improving soil quality, decreasing soil erosion, and enhancing economic returns. Ft. Collins, Colorado, scientists enhanced the cropping system/water quality model, RZWQM, to include winter freezing/thawing and a new pesticide process and developed a user-friendly interface. This model is now published. Researchers from Watkinsville, Georgia, evaluated cotton yield and N and P losses in runoff and leachate from a cotton/rye cropping system managed under either conventional- or no-tillage and fertilized with either ammonium nitrate or poultry litter. Results indicate that yield could be improved up to 50 percent water quality maintained by adopting no tillage and fertilizing with poultry litter.

IMPACT/OUTCOME: Alternatives are now available for producers in areas throughout the country to determine which potential crops, rotations, conservation tillage and soil management systems they can use to tailor cropping systems to their management needs. This will enable producers to develop economically advantageous and environmentally friendly production systems.

PERFORMANCE GOAL 4.1.1.2: Experimentally demonstrate the appropriateness of watershed-scale technologies and practices that protect the environment and natural resources.

Indicators:

During FY 2000, ARS will

develop scientifically defensible guidelines and decision-making tools to assist the national dairy, pork, and poultry producer groups; farmers; NRCS; and EPA in developing nutrient management plans for phosphorus and animal manure application. Tools will be provided to establish agronomically and environmentally sound threshold soil phosphorus (P) levels, determine P-based manure application rates, and select effective remedial strategies to minimize P loss to surface waters. This will assist States and national regulatory agencies in meeting their mandates to revise the nutrient management planning process of animal feeding operations, and provide criteria for managing nutrients in water bodies as requested in the Clean Water Action Plan.

ACCOMPLISHMENTS: ARS scientists from University Park, Pennsylvania, and their cooperators have developed a predictive tool called a phosphorus index to identify areas in a pasture that are vulnerable to phosphorus losses.

IMPACT/OUTCOME: Producers, various support agencies (e.g., the NRCS and EPA), and consultants can use the index to determine areas in a pasture where manure can be safely applied and areas where special practices or precautions are required.

complete an evaluation and assessment of different cropping practices and farming systems from the MSEA program that will provide a comprehensive picture of the fate and transport of herbicides, nitrate, and sediment within Midwestern agricultural watersheds. The Clean Water Action Plan and other conservation programs encourage States to develop Federal-State partnerships to assess the potential for using tax incentives to protect water quality, provide increased wildlife habitat, and encourage conservation of critical private lands.

ACCOMPLISHMENTS: Researchers at Columbus, Ohio, have demonstrated that a new water management technology, called a wetland/reservoir subirrigation system (WRSIS), can reduce off-site losses of runoff water, including sediments and nutrients, by as much as 80 percent to lakes and streams.

IMPACT/OUTCOME: A cost benefit analysis of the WRSIS Technology based on current economic values, was used to compare operation and investment costs with benefits such as improved crop production, improved water quality, increased residual land value, decreased tax liability, and wetland mitigation payments for this new water management technology. The results suggest that many farmers will not be able to adopt the system unless a mitigation payment or subsidy is received for the environmental benefits that are provided.

ACCOMPLISHMENTS: A jet test device suitable for measuring stream bed erodibility in the field or laboratory was developed at Stillwater, Oklahoma.

IMPACT/OUTCOME: There was no previously established or accepted procedure for measuring stream bed erodibility, but this new device will be able to ensure optimum placement of stream stabilization methods.

ACCOMPLISHMENTS: The National Sedimentation Laboratory at Oxford, Mississippi, has developed technologies and procedures for characterizing both quality and quantity of sediment impounded in aging hydraulic structures.

IMPACT/OUTCOME: Since more than 10,000 flood control structures built by NRCS are being adversely affected by sediment buildup, the procedures are needed for assessing whether these structures need to be rehabilitated or decommissioned.

ACCOMPLISHMENTS: Scientists at Baton Rouge, Louisiana, demonstrated that controlled subsurface drainage, using underground plastic pipes to maintain the water table at a shallow 2-foot depth, can reduce nitrate-nitrogen losses in the discharge waters by over 20 percent.

IMPACT/OUTCOME: This finding has the potential to reduce nitrogen loadings from a large portion of the Mississippi River Basin to the Gulf of Mexico. Concerns still exist in terms of the high cost of controlled subsurface drainage systems. However, consideration should be given to providing increased funding, under the EPA cost-sharing programs and the USDA conservation program, for this best management practice that may be one of the most feasible alternatives for reducing the hypoxic zone (low level of dissolved oxygen) in the Gulf of Mexico.

demonstrate the effectiveness of natural and constructed biofilters, riparian areas, wetlands, and buffer strips for trapping sediment and other contaminants before they reach surface waters. The Clean Water Action Plan calls for farmers to create two million miles of buffers adjacent to waterways by 2002, construct 100,000 acres of wetlands by 2005, and restore 25,000 miles of stream corridors by 2005.

ACCOMPLISHMENTS: Previous studies have shown that grass buffers can reduce the amount of a herbicide (such as atrazine) being carried to a stream, but new information from Ames, Iowa has shown that the grass buffers can also reduce leaching of the herbicide to groundwater.

IMPACT/OUTCOME: Grass buffers, planted to switchgrass, big bluestem or eastern gamagrass, may have an added advantage of reducing the losses of herbicides to groundwater, over other forested or mixed tree

and grass buffers that require a long period of time to establishments. Further research is needed to confirm these results at other locations.

demonstrate how the integration of remotely sensed imagery with ground-based data can be used to obtain spatially distributed information on vegetation and water use in rangeland watersheds. These monitoring strategies and interpretive methodologies will provide ranchers and public land managers with new approaches for improving the management of rangelands.

ACCOMPLISHMENTS: The techniques were demonstrated to ranchers in Arizona.

IMPACT/OUTCOME: These monitoring strategies and interpretive methodologies will provide ranchers and public land managers with new approaches for improving the management of rangelands.

STRATEGY 4.1.2: Global change: Increase understanding of the responses of terrestrial ecosystems to manmade and natural changes in the global environment.

PERFORMANCE GOAL 4.1.2.1: Documentation of agriculture's effects on the global environment.

Indicators:

During FY 2000, ARS will

compare amounts of organic carbon in plots of soil maintained for decades with different tillage and crop production systems in order to define more accurately the extent that conservation practices have removed greenhouse gases from the atmosphere.

ACCOMPLISHMENTS: Identification and quantification of practices that help maintain soil organic matter are necessary to delineate management systems for sustaining crop production without degrading the environment. Long-term experiments are important to assess changes in soil organic matter due to soil and crop management. Carbon was measured in semi-arid soils of the Pacific Northwest where crop management experiments have been conducted by ARS for 30 to 65 years. Most systems lost soil organic matter when rotations included summer fallow. Reducing tillage or adding nitrogen fertilizer to increase crop growth decreased losses of soil carbon.

IMPACT/OUTCOME: Based on these long-term plots, ARS scientists project that soil organic matter can be maintained or increased only if crop residues are returned to soil, erosion is kept below 2-4 tons per hectare, moldboard plowing is avoided, and fallowing is eliminated or practiced one year or less in four or five. These experiments allow development of crop management criteria to maintain soil quality and achieve maximal carbon sequestering capability. Such criteria help guide managers and inform policymakers on development of agricultural resource conservation programs.

ACCOMPLISHMENTS: Researchers from Ft. Collins, Colorado, determined that across a 13 State region in the Great Plains the average rate of soil carbon sequestration was 500 to 900 pounds per acre at Conservation Reserve Program (CRP) sites. Soil conditions in cropland, nearby native grassland, and replanted grasslands (CRP) were compared by Bushland, Texas, researchers. Soil carbon contents were lowest in cropland using plow tillage and fallow periods and highest in native grassland. Higher soil carbon contents improved soil aggregation and other soil properties. Planting grass on cropland improves soil conditions, but crop production is lost. More residue and, therefore, more carbon was added to soil in Colorado and North Dakota when nitrogen fertilizer was used. This data is important to understanding the impact of fertilization on soil carbon. ARS scientists at St. Paul, Minnesota, demonstrated that conservation tillage, corn residue return, and nitrogen fertilization were all required for net increases in soil carbon storage. Scientists at the National Soil Tilth Laboratory documented the relative contributions of surface residue and roots under simulated no-tillage management to the formation of soil organic matter. After a 1-year

incubation, 66 percent of the carbon in surface residue had been lost as carbon dioxide, 11 percent was still on the surface, and 16 percent was in new soil organic matter. In comparison, 56 percent of the root derived carbon was respired as carbon dioxide, and 42 percent was in new soil organic matter. ARS researchers in St. Paul, Minnesota, using newly developed chemical characterizations, have developed indicators that humic substances and current soil management play a critical role in the deep formation and persistence of the soil carbon sink below the tillage zone. In Florence, South Carolina, researchers demonstrated that long-term conservation tillage practices will result in a build-up of soil organic carbon in Coastal Plain soil. Soil organic matter levels in the surface 2 inches continue to increase at a rate of 0.1 percent per year in long-term conservation tillage plots that include corn, wheat, and soybean in rotation. In Kimberly, Idaho, scientists found that soil organic carbon was greatest in irrigated pastures, less in conservation tilled crops, less in native sagebrush, and least in plowed fields. Grazinglands, because of their vast areal extent, have a large potential for sequestration of carbon in soil. In El Reno, Oklahoma, scientists showed stocking rate affected the amount of carbon stored in the soil differently for a lighter textured soil than for a heavier textured soil. Soil properties, therefore, must be considered if grazinglands are to be used as a site to store carbon. Pasture management impacts soil C sequestration potential according to research conducted at Watkinsville, Georgia, where researchers determined the amount of carbon in surface residue and soil in grazed versus nongrazed systems. Findings are supportive of the concept of using grazinglands for soil carbon storage.

IMPACT/OUTCOME: Many scientific and policy discussions are currently occurring both at domestic and international levels on the potential for using crop and grazinglands to sequester carbon. Both soil conservation and greenhouse gas reduction benefits can result from using soils to store carbon. As a result of ARS research, such as that provided above, sound scientific information will be available for decision makers and land managers to base their decisions on. For example, this information will be used by an ARS Task Force to provide advisories to farmers and environmental policymakers on the potential for reduction of atmospheric carbon dioxide related to agriculture and to develop soil carbon credit products.

conduct more detailed studies of agriculture's role in greenhouse gas emissions and make more accurate assessments of how changes in soil management can reduce atmospheric CO₂ levels.

ACCOMPLISHMENTS: Knowing the current soil carbon stock, the rate of accumulation, and the total storage potential is important to managing soil resources and advising policy makers. Using land-use data and an internationally accepted method of "carbon accounting," ARS scientists estimated that U.S. crop lands and grazing lands are accumulating 20 million metric tons of carbon per year. In related studies, ARS researchers projected that another 180 million metric tons of carbon might be stored in these soils over the next several decades if production practices best for carbon accumulation were used.

IMPACT/OUTCOME: Management of crop lands and grazing lands in ways that enhance carbon sequestration can have benefits to soil, water, and air quality on and off the farm. These estimates of sequestration rate and storage potential also figured prominently in the U.S. Government's negotiations concerning possible international agreements to limit greenhouse gas emissions. A book was also published to inform the science and policy communities about the potential of U.S. grazing lands to sequester carbon and mitigate the greenhouse effect.

<p>PERFORMANCE GOAL 4.1.2.2: Documentation of how changes in the global environment affect agriculture.</p>
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Indicators:

During FY 2000, ARS will

determine how rising CO₂ levels in the atmosphere will alter the yield and water requirements of sorghum, a crop of major importance domestically and internationally, in cooperation with university scientists and the Department of Energy.

ACCOMPLISHMENTS: The concentration of carbon dioxide in the atmosphere has been increasing steadily since the mid-1800s. In addition to its possible influence on agriculture through the “greenhouse effect,” carbon dioxide affects crop and grazing plants directly through its effect on photosynthesis and other physiological functions. ARS scientists exposed sorghum plants throughout the growing season to ambient or approximately 1.5X ambient carbon dioxide in a free-air carbon enrichment experiment. Effects of increased carbon dioxide on plant biomass and grain yield were minimal if the plants were kept well irrigated. However, carbon dioxide stimulated growth (by 13 percent) and grain yield (by 17 percent) if the plants were drought-stressed.

IMPACT/OUTCOME: When soil moisture is ample, carbon dioxide is projected to have little impact on sorghum growth and yield. However, sorghum is produced in areas of the U.S. and Africa where drought conditions are common, and in those areas, increased carbon dioxide is projected to increase productivity, assuming no other environmental factors attenuate the stimulation. Food security is an important issue facing the world as both the human population and atmospheric carbon dioxide continue to increase therefore, the results of this research will be important in projecting food supplies and developing food production and management policies around the globe.

conduct research that provides a better understanding of complicated interactions between rising atmospheric CO₂, rising temperatures and changing amounts of rainfall on crop production, competition with crops, and the availability of water for crop and forage production.

ACCOMPLISHMENTS: “Global change” encompasses many changes in the environment, including long-term alterations in temperature, moisture, and the chemical characteristics of the atmosphere. ARS researchers have conducted experiments to examine some of these interactions. Averaged over four years of experiments, a 50 percent increase in atmospheric carbon dioxide increased seasonal above-ground biomass of wheat plants by 11 percent when plants were adequately irrigated and given nitrogen fertilizer. However, when plants were subjected to drought stress, the growth stimulation by elevated carbon dioxide increased by an average of 15 percent; when the plants were nitrogen-deficient, the growth stimulation by extra carbon dioxide dropped 8 percent. Because increased carbon dioxide causes partial closure of pores on corn and soybean leaf surfaces, less water vapor is lost from leaves in high-carbon dioxide conditions; ARS modeling results showed that the decreased evaporative cooling of the leaves causes increased temperature and decreased relative humidity above the crop and could cause feedback interactions among carbon dioxide, temperature, water loss, and crop response.

IMPACT/OUTCOME: Complex changes in many aspects of the environment make projecting future food production very uncertain. These uncertainties can be reduced only through measuring crop responses to multiple factors in complex experiments. Results of ARS research provides data for crop response models and economic models so that policymakers and resource managers can have greater confidence in projections of agricultural production in the future when environmental change and variability could be greater than it is today.

STRATEGY 4.1.3: Cropland and grazingland sustainability: Develop cropland and grazingland management strategies that will improve quality, quantity, and sustainability of food and fiber products needed for U.S. competitiveness.

PERFORMANCE GOAL 4.1.3.1: Demonstrate cropland and grazingland management strategies that improve productivity and efficiency of croplands and grazinglands.

Indicators:

During FY 2000, ARS will

test a distributed hillslope sediment yield model coupled with NRCS range site descriptions to assess rangeland health. The simulation model will provide a repeatable means to quantify the soil/site stability component of the rangeland health assessment methodology.

ACCOMPLISHMENTS: The tests were successful.

IMPACT/OUTCOME: The simulation model will provide a repeatable means to quantify the soil/site stability component of the rangeland health assessment methodology.

release new varieties of forage grasses better adapted to the environmental conditions of the Great Plains and the Inter-mountain West, which are more productive and more persistent on grazed rangelands and pastures.

ACCOMPLISHMENTS: At St. Paul, Minnesota, scientists have isolated two genes involved in the production of organic acids that provide the energy for symbiotic nitrogen fixation in alfalfa root nodules. They also found another gene that regulates root nodule formation. Knowledge of these genes is being used to develop alfalfa varieties that are more efficient nitrogen fixers and more useful in phytoremediation of nitrate-contaminated sites. At Logan, Utah, scientists have made available a cultivar of crested wheatgrass, called RoadCrest, that will increase soil conservation along roadsides and similar sites.

IMPACT/OUTCOME: Improving the adaptability, establishment, persistence, productivity and quality of forage plants for livestock production improves profitability by reducing costs, increasing animal performance, and conserving natural resources. Using improved forage plants for other uses such as phytoremediation and turf grasses helps lower the costs of conservation and environmental improvements.

propose prototype procedures and methods for assessing the ecological status or "health" of rangelands in cooperation with NRCS and EPA.

ACCOMPLISHMENTS: At Las Cruces, New Mexico, researchers released a manual on desert rangeland monitoring for range conditions and ecological health. Workshops have been held to train public and private land managers to use the manual which is now being evaluated in the field and revised as needed.

IMPACT/OUTCOME: Provide land managers and other interested parties with useable, simple, affordable and sustainable technologies for monitoring and assessing desert rangeland conditions so that timely action can be taken to improve management practices.

genetically characterize (sequence or clone) at least one of the several genes for asexual seed reproduction of eastern gama grass, a native forage plant. Detailed knowledge of this and related genes will help researchers produce hybrid crops with genetic characteristics that are stable over generations, which may tangibly decrease hybrid production costs.

ACCOMPLISHMENTS: The shift in eastern gamagrass from sexual to asexual (apomixes) reproduction is correlated with chromosome number. Sexual reproduction occurs with 36 chromosomes while apomixes usually occur with a higher number. However, ARS scientists have produced two hybrid plants with 72 chromosomes that reproduce sexually and produced sufficient seeds for inheritance studies to help isolate the genes controlling asexual reproduction. Such complexity in chromosome numbers indicates that the genetic control of apomixes may be more indirect than thought and isolating and characterizing the responsible genes will be challenging.

IMPACT/OUTCOME: While genetically characterizing apomixes is high-risk research, success would have profound consequences by providing a low-cost way of stabilizing the genetic constitution of improved varieties and allowing hybrid vigor and uniformity to be faithfully transmitted to subsequent generations of forages, corn and other cereal crops.

expand research on grazing management, especially as related to development of approaches to grazinglands utilization which are more environmentally compatible, and that will provide land managers with tools for enhancing the ecological condition of grazing lands. Research will also be initiated on the foraging behavior of livestock to provide guidance for testing methods of improving forage utilization by improving the distribution of livestock across extensive areas of rangeland. New research will be directed at integrating multiple sources of forages (from croplands, annual and perennial pastures, and rangelands) to provide green forage over a longer portion of the year, thereby reducing a producers' need to purchase expensive feeds from off farm sources.

ACCOMPLISHMENTS: The completion of long-term grazing trials has provided information on the relationships between grazing management and ecological conditions. A 60-year grazing trail on the Central Plains Experimental Range near Nunn, Colorado found that plant biodiversity was greatest under moderate and heavy stocking rates. Under light grazing, the plains prickly pear cactus dominated. A 10-year project at Woodward, Oklahoma determined that a sustainable carrying capacity for all resource values on sandy grasslands in the Southern Great Plain was about 17 acres per cow-calf production unit. A key tool in managing vegetation and ecological condition is controlling where animals graze. Water and salt placement have long been used to influence the distribution of beef cattle. Experiments at Burns, Oregon using global positioning system collars in the northern Great Basin found that water can be used effectively but salt is not effective as a distribution tool. A problem in the southeast is the seasonal limitations of the tropical warm-season grasses commonly used. These grass are well adapted to the region but do not grow well during the winter season, have relatively low nutritional value and require high levels of nitrogen fertilization. One solution is to grow a tropical forage legume, *Leucaena*, with the grasses. However, *Leucaena* will cause toxicity problems in both livestock and zoo animals unless the right mix of rumen bacteria are present. ARS researchers at Brooksville, Florida, worked with the University of Florida and Walt Disney World's Animal Kingdom to find safe ways to transfer bacteria cultures into wildlife and livestock that lacked them. They compared transferring cultures donated from previously colonized animals with preserved (frozen) pure cultures. The pure cultures worked satisfactorily and opens the way to transferring cultures without the risk of also transferring disease. While this is important to livestock producers, it is vital when there is a need to transfer a culture to endangered species maintained in zoos.

IMPACT/OUTCOME: Understanding the interrelationships between livestock, forages and ecosystems is vital to designing practical management systems that are simultaneously profitable, environmentally sound, and provide options for dealing with disease, pest and climatic risks.

indicate methods for the establishment of livestock, forages, and trees in agroforestry systems.

ACCOMPLISHMENTS: Quantified herbage productivity, seasonal distribution, and botanical composition of a mixture of sown grasses and legumes growing in a light gradient under an established stand of conifers (mixed species). Mature sheep grazed the existing understory of the coniferous tree site, were used to tread in surface applied seed and grazed the canopy as part of a rotational grazing system. Herbage was extremely low in nonstructural carbohydrates and relatively high in total nitrogen suggesting possible nutritional concerns for growing livestock.

IMPACT/OUTCOME: Findings will serve as a basis to optimize land-use efficiency and develop multiple-use options for wooded sites on pasture-based livestock farms.

OBJECTIVE 4.2: Risk management: "Improve risk management in the U.S. agriculture industry."

STRATEGY 4.2.1: Economic and environmental risks: Reduce economic and environmental risks through improved management of agricultural production systems.

PERFORMANCE GOAL 4.2.1.1: Risk-reduction strategies and methods transferred to the Nation's agricultural industry.

Indicators:

During FY 2000, ARS will begin integrating remotely sensed data with crop growth models. This information will be used to increase the accuracy of decision support tools for crop production and profitability.

ACCOMPLISHMENTS: New indices and sensors were combined and tested at Phoenix, Arizona, and Lincoln, Nebraska, to improve opportunities for the precision application of fertilizer and water, to enhance groundwater quality. At Phoenix, the researchers used a combination of a new canopy chlorophyll content index and a refined crop water stress index to detect nitrogen and water deficiency, while researchers at Lincoln, Nebraska updated the chlorophyll index to improve estimates of crop nitrogen and grain yield predictions.

IMPACT/OUTCOME: The ability to convert remotely-sensed data into treatment maps for fertilizer applications on irrigated and dryland crops and for irrigation water application on irrigated crops, provides agricultural producers with a powerful and cost-effective management tool.

STRATEGY 4.2.2: Weather and environmental risks: Develop concepts and technologies for predicting and reducing the socio-economic costs and resource damages associated with extreme weather variability.

PERFORMANCE GOAL 4.2.2.1: Improve strategies and technologies that reduce the effects of extreme weather variability.

Indicators:

During FY 2000, ARS will demonstrate a technology to provide geographically site-specific radar-based precipitation estimates for public and private lands that lack on-site precipitation measurements, enabling producers and resource managers to better cope with extreme weather variability in scheduling vegetation management and cropping and grazinglands operations.

ACCOMPLISHMENTS: Building on other agencies' efforts enables ARS scientists to develop ways to predict and manage water resources in the face of weather and climate variability. ARS researchers developed new coefficients for a model used by the National Weather Service to convert data obtained by radar to estimate precipitation. The ARS coefficients improved the accuracy of a models' estimates of precipitation that falls during storms in the Inter-mountain West.

IMPACT/OUTCOME: Historically, weather and climate variability and unpredictability have been the greatest constraints to agricultural production, so any improvements made in predictions and understanding their limitations helps managers plan for water availability. This research reduces the unpredictability of water supplies in western rangelands, where water availability for forage plants can limit animal productivity. Better knowledge of water availability helps producers plan seasonal production strategies around the supply of water resources.

ACCOMPLISHMENTS: Scientists at the Northwest Research Center at Boise, Idaho, developed a new and improved model that will enable the National Weather Service to improve radar-precipitation estimates in the Inter-mountain West.

IMPACT/OUTCOME: The National Weather Service operates the NEXRAD Doppler radar systems at more than 150 sites across the west. The computer model used to improve estimates of precipitation and provide advance prediction for weather hazard assessments, which was developed at the Boise NEXRAD radar

location can likely be extended to other sites in the Northwest.

ACCOMPLISHMENTS: An analysis of the rainfall records of the Great Plains by scientists at El Reno, Oklahoma, showed that the ability to predict actual precipitation values at some specific location remains quite limited.

IMPACT/OUTCOME: These findings indicate that it is extremely difficult to predict the long-term effects of drought for both agricultural and rural communities. The lack of predictive capability leaves the potential impact of future agricultural productivity and the potential for meeting the water requirements of the rural communities in doubt.

ACCOMPLISHMENTS: Research conducted at Coshocton, Ohio, on groundwater conditions showed that stable estimates of average and median concentrations can be achieved if 10 wells were used with a well density of one well per acre.

IMPACT/OUTCOME: While these results may not have general application, they document that the natural variability of water quality in underlying aquifers must be considered when characterizing specific conditions, determining sampling needs, and assessing the effectiveness of measures to protect these resources.

ACCOMPLISHMENTS: Scientists in Oxford, Mississippi, saved the U.S. Army Corps of Engineers an estimated \$3.4 million by performing an extensive topographic evaluation of the Yalobusha River Basin which reduced the number of required grade control structures the Corps would have to use.

IMPACT/OUTCOME: The potential for catastrophic flooding along the downstream reaches of a River Basin has increased dramatically since the 1960s because of channel dredging, straightening, and resulting natural processes. The evaluation system that was used could work in other stream systems and save a significant amount of time and money in remediation efforts, disaster cleanup, and disaster relief.

OBJECTIVE 4.3: Safe production and processing: "Improve the safe production and processing of, and adding of value to, U.S. food and fiber resources using methods that maintain the balance between yield and environmental soundness."

STRATEGY 4.3.1: Environmentally safe pest management: Develop environmentally safe methods to prevent or control pests (insects, weeds, pathogens, etc.) in plants, animals, and ecosystems.

PERFORMANCE GOAL 4.3.1.1: Deliver integrated pest management strategies that are cost effective and protect natural resources, human health, and the environment.

Indicators:

During FY 2000, ARS will

develop new methods to mass produce beneficial insects such as parasites and predators of insect and weed pests. develop new artificial diets, automate processing and harvesting equipment, and improve methods of distributing and releasing mass produced beneficial biological control agents.

ACCOMPLISHMENTS: ARS scientists at the Biological Control and Mass Rearing Research Unit in Starkville, Mississippi, have developed a new rack for holding *Lygus* species (such as tarnished plant bug) egg packets for parasitization by *Anaphes iole* that is 43 percent more efficient than the previously used rack, allowing semi-automated harvesting of eggs. The scientists also developed: an artificial diet, which contains no insect components, and techniques that support *in vitro* development of *A. iole* to the prepupal stage; and a mechanized device for preparing Gelcarin oviposition packets for rearing of *Lygus* species.

Developed an improved artificial diet for rearing of the coffee berry borer.

Developed artificial diet (patent pending) for phytophagous and zoophytophagous stinkbug insects (e.g., *Lygus* species) that allows production of species that could not previously be reared on artificial diets, and reduces costs of producing these insects by 95 percent.

Developed new technique ("dimple method") for packaging/delivering artificial diets for lacewings and other predatory bugs (tested by ARS and by a CRADA partner, Beneficial Insectary). Approved by Patent Committee for patent application.

IMPACT/OUTCOME: Improved diet for the insect predator *Geocoris punctipes*, including discovery of anti-nutrients and ways of ameliorating them. Also, discovered sources of dietary degradation and methods of preserving diets, and diet-borne factors that reduce oxidative stress.

identify new sampling and control procedures for the Asian longhorned beetle, a newly introduced pest that is damaging many species of hardwood trees in New York City and Chicago. This may include the identification of chemical attractants produced by either the beetle or by its preferred host plants.

ACCOMPLISHMENTS: First found in the U.S. infesting trees in New York in 1996 and in Chicago in 1998, Asian longhorned beetles (ALB) have been intercepted at ports in 17 states. ARS scientists at Newark, Delaware, have discovered new information never before recorded on ALB feeding behavior. The scientists and colleagues at the State University of New York in Syracuse have been developing a feeding noise recognition system. It generates an acoustic "fingerprint" as the beetle larvae feed within the two different tree tissues that they commonly inhabit - inner bark and inner wood. A functional prototype detection system should be available within a year.

IMPACT/OUTCOME: An acoustical Asian longhorned beetle detection system should give scientists and the regulatory agencies effective technology to detect trees which are infested so control measures can be implemented in a timely manner to help mitigate the spread of this destructive pest.

develop new biological control agents for several major target weed species including kudzu, tropical soda apple and saltcedar. Methods are currently being developed to mass produce parasitized caterpillars that can be released on kudzu. ARS scientists believe that these beneficial agents will not only eat the kudzu, but the resulting parasites are expected to attack and kill crop damaging caterpillars in nearby agricultural fields.

ACCOMPLISHMENTS: Three insect species were received into the Containment Facility at Temple, Texas for biological control of saltcedar: *Diorhabda elongata* from China and Kazakhstan, *Psectrosema noxium* from Kazakhstan, and *Cryptocephalus sinaita* from Israel. Field-cage studies of *D. elongata* were conducted at ten sites across six western states. A native true bug, *Tupiocoris notatus*, was found to induce chlorosis on tropical soda apple. Additionally, common fungi (*Fusarium* and *Colletotrichum*) were found to infect tropical soda apple.

IMPACT/OUTCOME: *Diorhabda elongata* was found to be host-specific to saltcedar, and it caused up to 90 percent defoliation in field-cage studies. Successful host range testing and overwinter survival fulfilled requirements of Fish and Wildlife Service (F&WS) and APHIS, and release permits from the field cages into the open field were issued by APHIS for test sites for spring 2001. This will initiate the 2-year experimental monitoring required at the sites before F&WS/APHIS reviews and gives final approval for full release. The soda apple bug lowered biomass and seed production of tropical soda apple in greenhouse tests. In small outdoor test plots, mortality of tropical soda apple infected with *Fusarium* and *Colletotrichum* was 80 percent. Because the bug and fungi are native or already have become established in the U.S., quarantine clearances are not required for release of the organisms.

develop new biochemical methods to identify the feeding preferences of several beneficial insects under natural field conditions. Using ELISA and biochemical markers, and/or rare elements, the feeding patterns

and impact of natural occurring beneficial insects will be assessed and the information used to help cotton and grain farmers avoid making unnecessary pesticide applications to their crops.

ACCOMPLISHMENTS: ARS scientists at Stillwater, Oklahoma, have developed a polymerase chain reaction (PCR) system for six species of Great Plains cereal aphids and demonstrated that it can be used to distinguish two closely related aphid species, the corn leaf aphid and bird cherry oat aphid, in the guts of ladybird and lacewing predators. This enables ecological investigations of the feeding preferences of these important biological control agents. Similarly, the group developed a PCR system for cereal aphid parasitoids of two wasp families and demonstrated their use in detecting parasitization. A PCR system was developed for separating closely related parasitoids of the Russian wheat aphid, and used it for the first time to demonstrate the establishment of an exotic parasitoid released in a classical biological control program.

IMPACT/OUTCOME: A subfamily-specific monoclonal antibody was used to study egg predation on the Old World bollworm.

collect parasitic insects from native apple orchards in Kazakhstan and China where apples and apple pests originate, then introduce them into U.S. areas to control exotic pests such as the codling moth and apple leafrollers.

ACCOMPLISHMENTS: ARS scientists in Yakima, Washington and University of California collaborators have made four natural enemy explorations to Kazakhstan and China, as well as into Uzbekistan and Kyrgyzstan. Six parasites of codling moth were collected and imported to the U.S.; three of these natural enemies have been released into the States of Washington and California. One parasite species (*Mastrus ribibundus*) has been provided to ARS collaborators for release in Colorado, Wisconsin, Minnesota, Pennsylvania, and Arkansas. A cooperative agreement with a scientist in Kyrgyzstan is ongoing and designed to evaluate the parasitoid complex of apple-feeding leafrollers.

IMPACT/OUTCOME: Imported parasite species from Kazakhstan have become established in numerous organic orchards where they were released. Parasitism of codling moth runs as high as 50 percent, thus significantly reducing populations of the pest and apple damage.

develop new remote sensing technology to identify pest attacks on important crop production and natural areas where exotic insects and diseases threaten to cause economic and/or environmental losses. Aerial photography surveys linked with geographic information systems to organize and display complex pest and weather data will assist scientists, extension agents, and farmers in making pest control decisions.

ACCOMPLISHMENTS: ARS scientists at Stillwater, Oklahoma, have preliminary data that indicate that the spectral reflectance of three bands of light (green, visible red, and near infrared) differ among wheat plots infested with differing population levels of greenbugs. This may lead to improved remote sensing of aphid populations in wheat and other crops.

IMPACT/OUTCOME: Stillwater scientists completed development and validation of a computer simulation model for the Russian wheat aphid on susceptible and resistant wheat varieties. This will serve as an aid in determining deployment strategies for resistant varieties that have been developed and as a pest management decision-making tool.

continue to provide critical identifications of unknown pest species, provide taxonomic revisions of critical groups of insects, identify new biological control agents, and produce updated keys to agriculturally important insect groups.

ACCOMPLISHMENTS: The Systematic Entomology Laboratory provided over 12,000 identifications of pest and beneficial insects to State, Federal, and private users in the last year. A major taxonomic treatment of pest armyworms was completed along with an identification key and an on-line database.

IMPACT/OUTCOME: The identifications provided have helped APHIS/PPQ stop new pests from entering the U.S. and mitigated the impact of pests already present. The identification key to armyworms is aiding pest managers and regulators to control these harmful pests on farms.

continue to collect and ship many new exotic biological control agents to ARS quarantine laboratories in Albany, California; Stoneville, Mississippi; Newark, Delaware; and Temple, Texas. The agents will be tested for their host specificity and appropriateness for release into the U.S. environment to control introduced pest insects and weeds.

ACCOMPLISHMENTS: ARS scientists, working with a large and diverse array of national and international agencies and scientists, received for the control of: coffee berry borer – one parasitoid from Latin America; for tropical soda apple – plant feeding *Gratiana* sp. from South America; for plant bug pests – *Campoletis* sp. and *Leiophron* sp. from Argentina; for Formosan subterranean termite – pathogens from Asia; for saltcedar – leafbeetles from China, and four other natural enemies from Eurasia; for eucalyptus psyllid and melaleuca - natural enemies from Australasia; for cape ivy – a gall fly and stem-boring moth from South Africa; for giant reed – new natural enemies from India and Nepal; for yellow star thistle – two natural enemies from Eurasia. The Newark lab, alone, collected or received 21 species, successfully reared 11 species, sent eight of these latter species to other investigators, and screened three species for host specificity.

IMPACT/OUTCOME: Parasitoids received for coffee berry borer have been released from quarantine for initial lab studies. Plant bug parasitoids are in initial culture stage. Tropical soda apple control agents are being reared in the greenhouse for efficacy studies. Certain pathogens isolated for termites show high efficacy in the laboratory. ARS received final state and federal approval for the open field release of saltcedar leafbeetles in spring 2001. Field cage studies in summer 2000 demonstrated total defoliation of test saltcedar plants in multiple sites across six western states. Based on the safety shown in the ARS tests, University of California-Berkeley scientists are now making open field releases in Southern California of a natural enemy of eucalyptus psyllids.

The cape ivy gall fly (*Parafreutreta regalis*) and a stem-boring moth (*Acrolepia* sp.) have the potential to significantly reduce the damage caused by Cape Ivy. New natural enemies of saltcedar and giant reed have the potential to significantly reduce the damage caused by these pest plants, and the testing currently underway both in the Albany quarantine and overseas will verify the safety of these agents. After host screening, a tachinid fly was released against gypsy moth in Maryland. Four species of parasites were released against the papaya mealybug, a new pest in Florida and Puerto Rico during 2000. Three species of pink hibiscus mealybug parasites released during 1998-2000 in the Virgin Islands are now established, and their efficacy is being evaluated by APHIS. In addition, 14 species of natural enemies were sent to cooperating scientists in ARS, Forest Service, state agencies, universities, and industry for further study during 2000.

release and evaluate new biological agents to control insect pests such as the silverleaf whitefly and the pink hibiscus mealybug. Both of these pests attack a large number of crop plants and cause extensive economic losses in areas where infestations occur. Scientists will attempt to control similar pests in the Caribbean Basin before they can invade the Continental U.S.

ACCOMPLISHMENTS: The southeastern and western parts of the U.S., particularly Florida and California, are subject to periodic introductions of exotic pests, such as the silverleaf whitefly and pink hibiscus mealybug. These exotic pests spread because of a lack of effective natural enemies to keep them in check. Exploration for candidate biological control agents has been ongoing for both of these pests by ARS scientists in Montpellier, France, in collaboration with the Animal and Plant Health Inspection Service (APHIS). Improvements in rearing pink hibiscus mealybug and its natural enemies have increased the capacity for large-scale rearing of parasitoid wasps and widened their distribution throughout infested areas of the Caribbean and the Americas by ARS scientists at Ft. Pierce, Florida. The foreign exploration for natural enemies of silverleaf whitefly is largely completed. However, evaluation of the spread and establishment of exotic natural enemies released in the U.S. continues as a cooperative effort between ARS, APHIS, and the

universities across the southern tier of the U.S.

IMPACT/OUTCOME: Research by scientists involved in a consortium effort from Texas, Florida, Arizona, and California shows that several introduced exotic parasitoids have survived over the years and are showing signs of establishment and control of silverleaf whitefly. The improved rearing methods for pink hibiscus mealybug have been transferred to USDA-APHIS and the Puerto Rico Department of Agriculture, who have been able to substantially increase their production of natural enemies for release and evaluation of control agents for this serious pest.

complete the shift of internal resources of the weed science program so that two-thirds of the resources are directed to biologically-based integrated weed management in line with the USDA Strategic Plan for "Invasive and Noxious Weeds" and the ARS Strategy on "Noxious and Invasive Weeds."

ACCOMPLISHMENTS: Scientists at Weslaco, Texas, used serial photography with global positioning systems to detect and map the invasive weeds in the Rio Grande River of south Texas caused by drought and weather variability.

IMPACT/OUTCOME: These invasive species maps are useful to water districts and wildlife management personnel, who are responsible for developing and implementing programs to control noxious weeds.

ACCOMPLISHMENTS: More than two-thirds of the weed science research budget has been shifted to programs pertaining to insects and diseases.

IMPACT/OUTCOME: Studies on insects and diseases may lead to development of biological control of weeds.

begin to change how biological weed control programs are planned and conducted in ARS. Scientists will prepare a long-term management plan for each targeted weed. The plans will concentrate on measuring the long-term impact of released biological control agents on a target weed and on closely related nontarget plants, incorporate cultural control/revegetation as an integral part of the biologically-based weed management program, and emphasize developing partnerships.

ACCOMPLISHMENTS: Long-term management plans, including assessment of biological control agent impact, revegetation, and nontarget effects have been prepared for Melaleuca, the paperbark tree, in the Florida wetlands, saltcedar, and weed of riparian areas, and for leafy spurge, an important weed of the Western Plains.

IMPACT/OUTCOME: Work to manage all three weeds is being coordinated with other Federal and State partners and university stakeholders.

STRATEGY 4.3.2: Integrated agricultural production systems: Develop knowledge and integrated technologies for promoting use of environmentally sustainable agricultural production systems.

PERFORMANCE GOAL 4.3.2.1: Demonstrate the effectiveness of integrated agricultural production systems in the improvement of natural resources and protection of the environment.

Indicators:

During FY 2000, ARS will combine the most appropriate attributes of the SPUR (Simulation of Production and Utilization of Rangelands) and WEPP (Water Erosion Prediction Program) models to produce an advanced simulation model SPUR-2000 that range management specialists can use to assist ranchers, and improve resource conservation and management at ranch and watershed scales in cooperation with NRCS.

ACCOMPLISHMENTS: SPUR2000 has been finished and a paper announcing and describing its characteristics accepted for publication. In the near future it will become available at the web site: <http://www.nwrc.ars.usda.gov/models/index.html>.

IMPACT/OUTCOME: The model has been used by NRCS in Nebraska to evaluate the impacts of conservation practices on land and water resources of Major Land Resource Area 106.

PERFORMANCE GOAL 4.3.2.2: Provide computer-based models and decision-support systems to farmers, public agencies, and private organizations.

Indicators:

During FY 2000, ARS will

field test the performance of decision support systems for water quality protection with NRCS. The field tests will assess how decision support systems, which include an embedded simulation model and a multi-objective decision-making component, can improve NRCS conservation planning and help ranchers select improved management systems. (Revised for clarity.)

ACCOMPLISHMENTS: Research has been completed on grazing management and water quality effects using a multi-objective decision support system developed at the Southwest Watershed Research Center in Tucson, Arizona. Sixteen years of measured and calculated data from four experimental watersheds showed that brush control and grazing management can be evaluated with the decision support system to reduce runoff and sediment losses and maximize production of vegetation.

IMPACT/OUTCOME: The decision support system is now being used by NRCS to evaluate the sustainability of rangeland health. In the future, ARS will be delivering a modification of this decision support system to NRCS and other customers to improve conservation planning and water quality protection for the croplands in the Midwest.

release the Kineros2 rainfall-runoff-erosion model on an Internet accessible website. This model will provide improved estimates of runoff flood peaks and soil erosion rates for designing efficient flood control structures and evaluating erosion control strategies.

ACCOMPLISHMENTS: The model is available for download at the web site, <http://www.tucson.ars.ag.gov/kineros/>.

IMPACT/OUTCOME: Seven major improvements have been made to the model. They are described on the above web site. The model will provide improved estimates of runoff flood peaks and soil erosion rates for designing efficient flood control structures and evaluating erosion control strategies.

field test decision support tools for the assessment of soil quality in cooperation with NRCS. The tools will range from brochures to computer programs. They are intended for use by farmers and other land managers to enable them to select management systems to enhance soil and environmental quality.

ACCOMPLISHMENTS: ARS scientists at the National Soil Tilth Laboratory, in cooperation with NRCS and CSREES, successfully completed a pilot study documenting how the NRCS National Resources Inventory framework can be used to monitor soil quality at a regional scale. The results demonstrate that it is possible to monitor changes in surface soil properties at the regional scale, but the ability to detect significant changes will vary depending on the soil property being evaluated. Also developed was a flexible framework for indexing soil quality. This framework was used to provide preliminary information to organic and sustainable agriculture farmers in the Central Valley of California. Akron, Colorado, researchers in cooperation with NRCS, quantified how rotation sequence and decrease in fallow periods affects soil quality. Soil health was improved

by eliminating summer fallow and using conservation tillage, and was influenced by crop rotation sequence. Soil quality assessments done by ARS researchers in Lincoln, Nebraska, demonstrated the utility of no-tillage management in maintaining soil quality and conservation benefits when CRP grasslands are returned to cropland.

IMPACT/OUTCOME: Maintaining and enhancing the soil resource is critical for sustainable food and fiber production and environmental quality. ARS has provided an understanding of relationships among inherent soil properties and dynamic soil biological, chemical and physical processes--especially with regard to carbon storage, soil aggregation, nitrogen and phosphorus cycling, and nitrogen use efficiency under different management systems. It has also led to the development of management practices to mitigate the off-site movement of pesticides into soil and water resources. The research and soil quality indexing techniques have generated substantial interest both in the U.S. and around the world. ARS has provided significant international leadership toward development and implementation of tools on soil quality for assessing the sustainability of agricultural and other soil management practices.

STRATEGY 4.3.3: Waste management and utilization: Develop and transfer cost-effective technologies and systems to use agricultural, urban, and industrial wastes for production of food, fiber, and other products.

PERFORMANCE GOAL 4.3.3.1: Demonstrate technologies to store, mix, compost, inoculate, incubate, and apply wastes to obtain consistent economic benefits while at the same time minimizing environmental degradation, nutrient loss, and noxious odors.

Indicators:

During FY 2000, ARS will

demonstrate that specially designed municipal biosolid composts can be used to remediate metal contaminated sites at a fraction of the cost of soil removal and replacement methods.

ACCOMPLISHMENTS: Specially designed mixtures or composts of municipal biosolids and other readily available byproducts have been used by scientists at Beltsville, Maryland, to revegetate and restore barren, highly metal-contaminated soils. Hazards associated with excess soil levels of zinc, lead and cadmium were overcome and a favorable environment for plant growth created.

IMPACT/OUTCOME: This remediation method allows contaminated sites to be reclaimed at a cost of \$2,000-\$10,000 per acre while soil removal and replacement methods cost about \$1,000,000 per acre-foot.

conduct research to link the manure management model with the beef production system model for use in raising beef cattle.

ACCOMPLISHMENTS: ARS scientists at Clay Center, Nebraska have developed a predictive computer model, based on knowledge of nutrient transformation mechanisms, to estimate the amount of nutrients contained in beef cattle feedlot manure for cropland application.

IMPACT/OUTCOME: The model has been used to identify information gaps and has been modified to serve as a producer decision tool. Efforts to link the manure management model to a beef production model have been more difficult than initially envisioned therefore, this goal has not been completed. The eventual linkage of the two models will allow beef cattle diets to be designed to make efficient use of feed nutrients, while providing guidelines for safe and efficient use in cropping systems of the manure generated.

develop new technologies for managing livestock waste and reducing odor production and emissions.

ACCOMPLISHMENTS: Treatment systems to manage nitrogen in wastewater depend on microbial

transformations of nitrogen from ammonium to nitrate forms (nitrification) and from nitrate to nitrogen gas (denitrification). ARS scientists from Florence, South Carolina used a municipal wastewater treatment technology, based on immobilization of nitrifying bacteria inside permeable polyvinyl beads, to remove ammonia from swine wastewater. In a one year pilot test of the technology, the immobilized nitrifying bacteria could remove 500 grams of ammonia-nitrogen per cubic meter of reactor per day.

IMPACT/OUTCOME: This technology has the potential to treat large amounts of ammonia in swine wastewater that would otherwise volatilize and escape to the environment.

evaluate near-infrared spectroscopy as a technique for quick analysis of nutrients in manure.

ACCOMPLISHMENTS: Producers need an estimate of the amount of nutrients in manure and the rate at which they will be supplied to crops. ARS scientists at Beltsville, Maryland have found that chemical “quick” tests gave a reasonable estimate of ammonia nitrogen in manure, but not organic nitrogen. However, they were able to demonstrate that the instrumental technique, near infrared spectroscopy, could be used to determine both ammonia and organic nitrogen in dairy manure.

IMPACT/OUTCOME: The eventual development of a portable near-infrared based instrument would allow rapid testing of nitrogen in manure. This information would allow producers to apply manure at rates needed by crops, while avoiding excess application rates that would pose a threat to water and air quality.

develop strategies to reduce emission of volatile organic compounds including ammonia from manure.

ACCOMPLISHMENTS: ARS scientists from Fayetteville, Arkansas found that treatment of poultry litter in commercial houses with alum (aluminum sulfate) could lower ammonia emissions and reduce the solubility of phosphorus in the manure. Field trials conducted in 15 states and on more than 30 million chickens demonstrated that the technology was cost-effective, that it reduced ammonia volatilization by up to 97 percent during the first four weeks of broiler production, and reduced runoff of phosphorus by 75 when alum treated litter compared to untreated litter was applied to pastures.

IMPACT/OUTCOME: This treatment technology improves broiler health while protecting air and water quality. Last year approximately 500 million broilers were produced on alum treated litter.

evaluate urease inhibitors, antimicrobial agents, and odor-masking agents in combination for controlling ammonia and odor emissions.

ACCOMPLISHMENTS: Scientists from Clay Center, Nebraska found that treatment of beef and swine manure with compounds such as essential oils and urease inhibitors reduced emissions of ammonia and other odorous constituents, and killed pathogens.

IMPACT/OUTCOME: Based on this research a commercially available product is now being marketed to control ammonia and odor emissions from beef and swine manure.

evaluate microbial cultures for seeding biofilters and biocovers for reducing odor from manure.

ACCOMPLISHMENTS: Researchers at Clay Center, Nebraska are developing methods for odor consumption using microbial communities found in feedlot soils and animal wastes. Their research, which is currently underway, involves identifying microorganisms responsible for odor consumption, stimulating the activity of these organisms, and using them in biofilters and biocovers to enhance their odor consumption capacity.

IMPACT/OUTCOME: This research should result in the development of reduced-cost, microbially-enriched treatment systems, which will metabolize odorous compounds to nonoffensive entities.

PERFORMANCE GOAL 4.3.3.2: Demonstrate the conversion of agricultural waste into liquid fuels and industrial feedstocks.

Indicators:

During FY 2000, ARS will

develop bioprocess and metabolic engineering technologies that expand biofuel feedstocks and add value to agricultural wastes.

ACCOMPLISHMENTS: Biomass contains a mixture of sugars: glucose, arabinose, galactose, and xylose. Normally, the presence of glucose inhibits the ethanol producing microorganisms from using the other sugars until glucose is exhausted. ARS scientists developed a series of recombinant ethanol producing microorganisms that use all of the above sugars in the presence of glucose (i.e., all sugars are consumed at equal rates despite the presence of glucose).

IMPACT/OUTCOME: These microorganisms have the potential of increasing ethanol yields, ethanol productivity, and lowering projected ethanol costs when using plant biomass as a feedstock.

develop technology to remove and concentrate nutrients from liquid animal waste and waste water. This process will protect environmental quality and create a source of concentrated, high-value, low-volume fertilizer.

ACCOMPLISHMENTS: ARS scientists at Florence, South Carolina have developed a treatment system to more effectively remove solids from liquid manure. The system, based on injection of polyacrylamide polymers to increase solids flocculation and a Deskins sand filtration system, reduces suspended solids in the liquid phase by a factor of 60 and produces removable solids cakes within 48 hours.

IMPACT/OUTCOME: The solids/liquid separation system captures over 80 percent of the organic nitrogen and phosphorus in the solid phase, resulting in a more valuable product for agricultural or horticultural uses.

GOAL V: Empower People and Communities, Through Research-Based Information and Education, to Address the Economic and Social Challenges of Our Youth, Families, and Communities.

Analysis of Results: This goal focuses primarily on activities designed to get research-based information to individuals and communities that will be useful for addressing a wide range of socio-economic issues. Under Goal V, 11 Indicators are aligned under 6 Performance Goals. Because of the unique and dynamic nature of research, several Indicators were added to the Report that did not first appear in the Annual Performance Plan for FY 2000. This was done to ensure that significant accomplishments that were not anticipated last year were reported. While it is not possible to report research accomplishments numerically, the progress projected in all 11 Indicators was completed or substantially completed during FY 2000.

OBJECTIVE 5.1: Economic opportunity and technology transfer: "Conduct agricultural research to promote economic opportunity in rural communities and meet the increasing demand for information and technology transfer throughout the U.S. agriculture industry."

STRATEGY 5.1.1: Rural development opportunities: Develop farming systems tailored to diverse agricultural production enterprises to enhance profits, sustainability, and environmental quality.

PERFORMANCE GOAL 5.1.1.1: Experimentally demonstrate the successful operation of small-scale production and processing systems, evaluate small scale animal production systems, and enhance high value agricultural products.

Indicators:

During FY 2000, ARS will determine whether high value nut trees and specialty crops, such as ginseng and mushrooms can be established in agroforestry systems being developed for Appalachia and the Ozarks. Establishment of such crops will lessen U.S. dependency on imports and provide higher income to these economically-depressed rural areas.

ACCOMPLISHMENTS: On-Farm research to develop production guidelines for long-culture of four species of edible specialty mushrooms was initiated.

IMPACT/OUTCOME: Development of a production system for high-value specialty mushrooms that utilizes on-farm resources and requires little capital investment can provide a supplemental income stream for small-scale farmers in hill lands such as Appalachia and the Ozarks. This system would be compatible with diverse agricultural enterprises, including organic production systems.

STRATEGY 5.1.2: Information access and delivery: Provide improved access to and dissemination of information to increase public knowledge and awareness of agricultural research, to aid technology transfer, and to speed up sharing of new knowledge.

PERFORMANCE GOAL 5.1.2.1: Make information on ARS research results and inventions available electronically via the Internet and similar resources.

Indicators:

During FY 2000, ARS will

develop an interactive Internet website to display and exchange information developed by the Semi-Arid-Land-Surface-Atmosphere (SALSA) global change research programs on global change and water resource management in the San Pedro Basin. Government agencies, organizations, and private citizens will be able to access SALSA research findings and other public information. SALSA collaborators will be able to interactively retrieve data from and deposit in a common database. This research and information tool will facilitate transfer of SALSA science products to user communities in the U.S. and abroad.

ACCOMPLISHMENTS: The SALSA program is a multi-agency, multi-national, global change research effort that seeks to evaluate the consequences of natural and human induced changes in semi-arid environments. Current SALSA research is focused on the upper San Pedro River basin in Southeastern Arizona, USA, and Northeastern Sonora, Mexico. ARS maintains the SALSA website at <http://www.tucson.ars.ag.gov/salsa/salsahome.html>.

IMPACT/OUTCOME: Visitors to the website can access research results and plans; contact information for SALSA collaborators and cooperators (including individuals in U.S. Federal and State agencies, Mexican agencies, universities, and others); publications and coverage by the news media; and SALSA documents, publications, and data. Using the Internet and other electronic resources, e.g., CD-ROM, the SALSA program has effectively transferred scientific and technical information to cooperators, U.S. Federal and Mexican agencies, the State of Arizona, environmental organizations, and the public at large.

use the Internet to expand, license and development opportunities of low phytate corn to reduce phosphate in the environment, and corn fiber oil to reduce the level of blood cholesterol. ARS will also expand electronic

methods to increase the adoption of biocompetitive agents in poultry and swine to increase food safety.

ACCOMPLISHMENTS: Modification of the OTT home page was initiated to provide a more user friendly vehicle for identifying ARS technologies available for licensing and partnerships. A plan was developed with the University of Massachusetts to proactively identify potential partners for the corn fiber oil. Two new licenses were negotiated for the low phytate corn. Negotiations are ongoing to license the biocompetitive agents for swine.

IMPACT/OUTCOME: These efforts have increased the likelihood of the successful transfer of these technologies to the private sector for commercialization.

PERFORMANCE GOAL 5.1.2.2: Provide more cost-effective and efficient public information and technology transfer.

Indicators:

During FY 2000, ARS will

continue to develop partnerships with States, the Minority Business Technology Transfer Consortium, and Rural Conservation and Development Councils to enhance small businesses in rural communities.

ACCOMPLISHMENTS: Members of OTT have attended numerous meetings of the RC&D councils, as well as regional rural development meetings with local industries and presented opportunities to obtain ARS technologies. Discussions are underway on several specific technologies.

IMPACT/OUTCOME: Successful transfer of these technologies will result in new jobs in rural America and enhance economic development in those regions.

submit 70 new patent applications.

ACCOMPLISHMENTS: 78 patent applications were filed.

IMPACT/OUTCOME: New technologies are available for licensing.

participate in 90 new CRADAs.

ACCOMPLISHMENTS: 69 new CRADAs were developed. Although the number of CRADAs were less than anticipated, the number of Trust Fund Cooperative Agreements with industry negotiated by OTT increased by 15 percent over the prior year.

IMPACT/OUTCOME: New partnerships were formed to advance the development and commercialization of ARS technologies.

license 30 new products.

ACCOMPLISHMENTS: 24 new licenses were established and 8 were renegotiated.

IMPACT/OUTCOME: Progress toward the commercialization of new ARS technologies.

develop 70 new plant varieties for release to industry for further development and marketing.

ACCOMPLISHMENTS: 73 plant varieties were released.

IMPACT/OUTCOME: New varieties are available to producers to enhance production, crop quality, and disease resistance.

PERFORMANCE GOAL 5.1.2.3: Research programs include information and technology transfer considerations.

Indicators:

During FY 2000, ARS will participate in National Program Reviews and Area Leadership Conferences to enhance technology transfer education and information.

ACCOMPLISHMENTS: Members of OTT made presentations at 3 National Program Reviews, 5 Area Leadership Conferences, and more than two dozen locations/laboratories.

IMPACT/OUTCOME: There is a heightened awareness of industry representatives and ARS scientist about ARS technology transfer policies and opportunities.

STRATEGY 5.1.3: Commercialize research results: Develop technology transfer systems that lead to commercialization of research results by industry.

PERFORMANCE GOAL 5.1.3.1: Provide small businesses with contacts and information on the programs available from public and private sources.

Indicators:

During FY 2000, ARS will expand efforts to identify groups that will enhance the probability of identifying partners for commercialization of ARS technologies. ARS will give particular emphasis to organizations concerned with minority businesses and rural development.

ACCOMPLISHMENTS: In addition to the efforts described in Performance Goal 5.1.2.2, OTT began the redesign of the exhibit used at trade and commodity shows to better highlight the type of technologies available for partnering and licensing. OTT hand outs for technology transfer are being redesigned to facilitate the education of industry on how to contact OTT. The technology Transfer Coordinators have become more proactive in working with potential small and minority owned business partners, and relationships have been established with several 1890 schools.

IMPACT/OUTCOME: Easier access to ARS technologies.

PERFORMANCE GOAL 5.1.3.2: Expand the types of agreements used by ARS and delegate signatory authority to the lowest feasible level.

Indicators:

During FY 2000, ARS will expand negotiation of licenses for ARS technology by training the Technology Transfer Coordinators in procedures. This will enhance customer service and facilitate the licensing process. OTT will provide oversight to ensure consistent implementation of Federal Regulations.

ACCOMPLISHMENTS: Three Technology Transfer Coordinators are negotiating licenses. Two others are being trained.

IMPACT/OUTCOME: This will enhance the licensing process to improve relationships with commercial

partners and speed the commercialization of ARS technologies.

ADMINISTRATIVE, PROGRAMMATIC, AND MANAGEMENT INITIATIVES

Initiative 1: Support Education: "Support Higher Education in Agriculture to Give the Next Generation of Americans the Knowledge, Technology, and Applications Necessary to Enhance the Competitiveness of U.S. Agriculture."

All of the activities relating to this initiative are cross-cutting in nature and are reflected in the strategies and performance measures under the five ARS Goals and Initiatives 2 and 3.

Initiative 2: National Agricultural Library: "Ensure and Enhance Worldwide Access to Agricultural Information through the Programs of the National Agricultural Library (NAL)."

In FY 2000, ARS reviewed its Strategic Plan as required by GPRA. The experience we had gained with GPRA over the previous several years led us to make substantial changes in Administrative, Programmatic, and Management Initiative 2 - The National Agricultural Library. The performance goals and indicators listed below were determined to no longer adequately measure the work of the National Agricultural Library. New performance goals and indicators were developed and the Agency has chosen to report its FY 2000 Accomplishments and Outcomes/Impacts against the new and more relevant indicators, which are contained in Appendix A. Next year, Appendix A will be fully integrated into both the Annual Performance Plans for FY 2002-2003 and the Annual Performance Report for FY 2001.

Means and Strategies: To successfully accomplish the activities under this initiative, ARS will need the level of human, fiscal, physical, and information resources portrayed in the budget estimates for fiscal years 1999 to 2003.

The proposed funding for FY 2001 includes \$2,000,000 in program increases. Funding increases include enhanced support of ARS research and information programs.

Verification and Validation: ARS currently conducts a series of review processes designed to ensure the relevance and quality of its work. A more detailed description of the evaluation plans can be found in the introduction to this plan.

STRATEGY 2.1: Access to information: Collect, organize, and provide access to information that supports agricultural programs and responds to information needs.

PERFORMANCE GOAL 2.1.1: Implemented selection guidelines for the electronic resources to be acquired and used by NAL.

Task completed in FY 1997.

PERFORMANCE GOAL 2.1.2: Expanded representation of electronic formats such as Internet resources, online databases, and digital documents in AGRICOLA and NAL's online catalog.

Indicators:

During FY 2000, NAL will

continue the transition from print to electronic collections.

begin using publisher supplied citation and abstract data in electronic form in the creation of indexing records.

make articles from indexed journals available immediately upon receipt by adding descriptive citation data to AGRICOLA in advance of subject indexing.

PERFORMANCE GOAL 2.1.3: A gateway is provided to a large body of electronic information on agriculture over a network such as the Internet.

Indicators:

During FY 2000, *NAL will continue to work with its land grant university partners to select and implement an infrastructure system which facilitates distributed searching for enhanced resource discovery using recently developed metadata and subject classification structure.*

PERFORMANCE GOAL 2.1.4: Demonstrate increased use of agricultural information by institutions of higher education.

Indicators:

During FY 2000, *NAL will*

as part of the Reference Reinvention Initiative, continue to transition to nonmediated services for users. Data will be collected to document the usage of more readily available electronic reference materials.

collect and analyze tracking information to determine customer needs. This information will be valuable in restructuring and enhancing the information and services offered to institutions of higher education.

STRATEGY 2.2: Meet customer needs for information: Anticipate and provide information products and services, including educational programs, that enable NAL's diverse customers to identify, locate, and obtain desired information on agricultural topics.

PERFORMANCE GOAL 2.2.1: The time for processing requests for services and delivering the information requested is further reduced.

Indicators:

During FY 2000, *NAL will*

expand electronic methods of document delivery to increase accuracy and efficiency of requested items. Implementation of an electronic request system for walk-in reader request patrons will begin. Patrons will request items on site for copy or loan through the online catalog ISIS. Requests will be sent from this subsystem electronically to the stacks for fulfillment and delivery of items.

continue to expand electronic services and identify emerging technologies to enhance program delivery.

PERFORMANCE GOAL 2.2.2: The gap between the time that information is published and made available in NAL-produced databases is further reduced.

Indicators:

During FY 2000, NAL will

decrease the elapsed time for indexing from receipt of the journal issues to release of articles to AGRICOLA.

begin addition of machine-readable records to the online catalog for older serial publications.

PERFORMANCE GOAL 2.2.3: Expanded provision of Internet and other technology-related training programs for NAL customers.

Indicators:

During FY 2000, NAL will develop web-based training to provide the ARS staff to better utilize electronic resources that have been obtained as a result of improved acquisition approaches for group access to expanded resources.

STRATEGY 2.3: Preservation of significant materials: Preserve significant and important works in agriculture and the fields related to agriculture to ensure availability of NAL's collections to current and future generations.

PERFORMANCE GOAL 2.3.1: Establishment of a national archive for agricultural literature that serves as a centralized storage facility for archival copies prepared by cooperators in the program.

Indicators:

During FY 2000, NAL will obtain the master microfilm negatives from phase two of the U.S. Agricultural Information Network (USAIN) preservation microfilming project for transfer to NUS.

PERFORMANCE GOAL 2.3.2: Development of a program for monitoring quality of electronically archived materials to ensure that the data remain accessible.

Indicators:

During FY 2000, NAL will work with the steering committee to produce a conference on metadata for the USDA and to develop further actions for preserving USDA digital publications.

Initiative 3: Creative Leadership: Promote Excellence, Relevance, and Recognition of Agricultural Research through Creative Leadership in Management and Development of Resources, Communications Systems, and Partnerships with Our Customers and Stakeholders.

In FY 2000, ARS reviewed its Strategic Plan as required by GPRA. The experience we had gained with GPRA over the previous several years led us to make substantial changes in Administrative, Programmatic, and Management Initiative 3 - Creative Leadership. The performance goals and indicators listed below were determined to no longer adequately measure the leadership activities of ARS. New performance goals and indicators were developed and the Agency has chosen to report its FY 2000 Accomplishments and Impacts/Outcomes against the new and more relevant indicators, which are contained in Appendix A. Next year, Appendix A will be fully integrated into both the Annual Performance Plans for FY 2002-2003 and the Annual Performance Report for FY 2001.

STRATEGY 3.1: Develop research agenda: Identify ARS program priorities and core research capabilities

and use them to provide leadership in development of the coordinated REE and national research agendas.

PERFORMANCE GOAL 3.1.1: The annual performance plan is delivered on time.

Indicators:

During FY 2000, ARS will meet all REE and Departmental deadlines for submissions required by the strategic plan.

PERFORMANCE GOAL 3.1.2: Meet REE deadlines for submission of material for inclusion in the Coordinated Research Agenda.

Indicators:

During FY 2000, ARS will meet REE deadlines for submission of materials related to the Coordinated Research Agenda.

PERFORMANCE GOAL 3.1.3: Annual conferences of public and private individuals are convened to discuss major researchable issues in agriculture and to articulate approaches to addressing these problems.

Indicators:

During FY 2000, ARS will

select the researchable aspects of a high priority national issue that will benefit from a broad public/private, Federal/State/local dialogue and convene an appropriate conference.

continue an annual conference of Federal, State, and industry representatives for the purpose of reviewing the progress of the new five year research, action and technology transfer plan, as well as to make control recommendations for the silverleaf whitefly that has caused \$200-500 million in losses across the Southern tier of the U.S.

PERFORMANCE GOAL 3.1.4: Rapid responses to crises.

Indicators:

During FY 2000, ARS will respond to threats to the security of American agriculture and the safety of the Nation's food supply.

STRATEGY 3.2: Civil Rights: ARS is committed to the principal of Civil Rights and the implementation of the Civil Rights Action Team Report. The ARS Civil Rights Staff (CRS) recognizes that systematic communication is important as a means of ensuring that its services meet the expectations and needs of its customers/stakeholders, including managers, supervisors, and employees.

PERFORMANCE GOAL 3.2.1: Written policies and guidance to facilitate implementation of the Civil Rights program.

Indicators:

During FY 2000, ARS will continue to develop policies, brochures, and fact sheets to facilitate implementation of the Civil Rights Program.

PERFORMANCE GOAL 3.2.2: Improve all aspects of the Title VII program which includes EEO training, data collection, and monitoring and evaluation.

Indicators:

During FY 2000, ARS will conduct on site EEO program evaluations to determine the extent to which ARS is complying with Equal Employment Opportunity requirements.

STRATEGY 3.3: Additional funding: Encourage acquisition of additional funding to improve ARS programs and priorities.

PERFORMANCE GOAL 3.3.1: Partnerships are established.

PERFORMANCE GOAL 3.3.2: Procedures are implemented.

PERFORMANCE GOAL 3.3.3: Outside support increases.

Indicators:

During FY 2000, ARS will meet or exceed the targets for securing additional funding.

STRATEGY 3.4: Customer service: Improve customer service.

PERFORMANCE GOAL 3.4.1: Improved customer satisfaction.

PERFORMANCE GOAL 3.4.2: Customer needs are identified.

STRATEGY 3.5: Management of facilities: Provide appropriately equipped Federal facilities required to support the research and information activities of ARS into the next century.

PERFORMANCE GOAL 3.5.1: Criteria and priorities identified.

Indicators:

During FY 2000, ARS will update annually the ARS facilities modernization plan which identifies ongoing repair and maintenance needs of existing Agency laboratory and support facilities.

STRATEGY 3.6: Maintenance of core research capabilities: Develop and implement comprehensive human resource systems and policies to support and enhance ARS' core research capabilities while maintaining the flexibility to shift research and form interdisciplinary teams to address emerging problems.

PERFORMANCE GOAL 3.6.1: Identify core capability requirements and develop a scientific staff to meet long-term research needs.

Indicators:

During FY 2000, ARS will

increase its core capability by significantly increasing the number of research scientist positions (SYs).

conduct three consolidated scientist recruitment cycles.

develop a core curriculum for new scientist orientation for use at field offices and laboratories.

implement a new Research Leader Training Program. A formal leadership training program will also be established, including orientation within Headquarters and the Areas.

PERFORMANCE GOAL 3.6.2: Establish a database of ARS experts by discipline and research areas of expertise.

ARS decided not to develop this database.

PERFORMANCE GOAL 3.6.3: Train 1,300 postdoctoral students, and competitively select 10 percent of them to fill full-time positions.

Indicators:

During FY 2000, ARS will continue its Research Associate Program as a source of qualified candidates for its permanent research positions.

STRATEGY 3.7: Provide administrative support to REE: Serve as the lead agency in providing administrative and financial management services for Research, Education, and Economics.

PERFORMANCE GOAL 3.7.1: Customer participation in planning processes.

Indicators:

During FY 2000, ARS will continue to monitor customer needs consistent with the AFM Strategic Plan and develop an AFM-wide customer survey to obtain feedback on customer satisfaction.

PERFORMANCE GOAL 3.7.2: Strategic Plan is developed and communicated to REE customers.

Indicators:

During FY 2000, ARS will collect customer feedback to identify changing priorities and begin refinement of its Strategic Plan.

STRATEGY 3.8: Program excellence and relevance: Ensure excellence and relevance of ARS programs through a variety of comprehensive reviews.

PERFORMANCE GOAL 3.8.1: Internal and external peer reviews are conducted on all research projects before implementation.

Reporting will begin in FY 2000.

PERFORMANCE GOAL 3.8.2: Review of the productivity, quality, and impact of individual scientists as scheduled in the Research Position Evaluation System (RPES).

Indicators:

During FY 2000, ARS will conduct RPES reviews of approximately 350 Agency scientists.

PERFORMANCE GOAL 3.8.3: Program reviews are conducted periodically, and programs are sustained or redirected as appropriate.

Reporting will begin in FY 2000.

STRATEGY 3.9: Improve financial management: ARS/Administrative and Financial Management will support Departmental efforts to improve financial management.

PERFORMANCE GOAL 3.9.1: Implement integrated management systems in USDA.

Indicators:

Reporting will begin upon issuance of Departmental evidence on the Foundation for Financial Information System (FFIS) for mandatory use by USDA agencies.

During FY 2000, ARS will

continue to work with the Office of Chief Financial Officer (OCFO) on the design and modification of the FFIS for use by REE.

continue to work with the NFC on implementing new and modernized financial systems for the REE agencies.

PERFORMANCE GOAL 3.9.2: Correct in a timely manner internal control deficiencies.

Indicators:

Reporting will begin upon issuance of Departmental evidence on the FFIS for mandatory use by USDA agencies.

During FY 2000, ARS will continue compliance with the FMFIA, including the timely completion of audit report recommendations and the timely correction of any FMFIA weaknesses that are identified.

PERFORMANCE GOAL 3.9.3: Make available reliable cost accounting information.

Indicators:

Reporting will begin upon issuance of Departmental evidence on the FFIS for mandatory use by USDA agencies.

During FY 2000, AFM will

continue to work with the OCFO and the NFC to implement USDA cost accounting standards on behalf of all REE agencies, and perform biennial reviews of user charges as required by OMB Circular A-25.

continue to review Agency operations for new potential user fee situations.

<p>PERFORMANCE GOAL 3.9.4: Clean and timely audit opinions are provided on audited financial statements.</p>

Indicators:

Reporting will begin upon issuance of Departmental evidence on the FFIS for mandatory use by USDA agencies.

During FY 2000, ARS will prepare, review, and certify the yearly consolidated financial statements of the REE agencies as required under the Chief Financial Officer's Act.

APPENDIX A

Effectively Marshal the Diverse Capabilities and Resources of ARS.

OBJECTIVE 6.1: Support Education: “Support higher education in agriculture to give the next generation of Americans the knowledge, technology, and applications necessary to enhance the competitiveness of United States agriculture.”

All of the activities relating to this objective are crosscutting in nature and reflected in the strategies and performance goals under the six ARS Goals.

OBJECTIVE 6.2: National Agricultural Library: “Serve as the primary agricultural information resource of the United States.”

STRATEGY 6.2.1: Increase awareness and use of National Agricultural Library (NAL) products and services: Collect, organize, and provide access to information that supports agricultural programs and responds to information needs.

PERFORMANCE GOAL 6.2.1.1: Maintain up-to-date data on customer information needs and satisfaction.

Indicators:

During FY 2000, *NAL will*

begin the process of reviewing information center programs ensuring targeted focus and customer satisfaction and collection of relevant data.

ACCOMPLISHMENTS: An Alternative Farming Systems Information Center review was convened to look at the center’s program and make recommendations. The final report was received with recommendations for future program directions.

IMPACT/OUTCOME: Increased and continued financial support from the Sustainable Agriculture Research Education Program of CSREES for the Alternative Farming Systems Information Center.

continue collecting data on reference and research information services and begin combining them with information center service data.

ACCOMPLISHMENTS: A system was established to collect and analyze incoming requests as to type of service needed and appropriate service point for delivery of material or answer.

IMPACT/OUTCOME: Refinements of the reorganization and reinvention of reference and information services can be made to continue speeding up delivery of reference and research information services.

PERFORMANCE GOAL 6.2.1.2: Integrate customer data into continuous refinement of operations.

Indicators:

During FY 2000, *NAL will continue to reduce turn-around times in serving customers by collecting*

data and incorporating results into customer service operations.

ACCOMPLISHMENTS: New Service Desk model of tiered services with reference triage allows use of library technicians to answer simple reference requests.

Based on the results of the Document Delivery Usage Study, the Document Delivery Services Branch and

Acquisitions & Serials Branch identified serial titles to be claimed, missing issues to acquire and a variety of other actions to be taken on specific titles.

IMPACT/OUTCOME: More efficient use of subject specialist librarians.

Increased availability of materials to fill document delivery and interlibrary loan requests speeds up responses to customers, reduces the number of items to be borrowed from other sources, and lowers associated costs.

PERFORMANCE GOAL 6.2.1.3: Develop and improve NAL information delivery systems.
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Indicators:

During FY 2000, *NAL will*

continue to develop and improve its web-based information delivery systems.

ACCOMPLISHMENTS: Three new Web sites have been made available and two information centers reformatted and refreshed their home pages. Several sites were recognized by professional organizations for their high quality.

IMPACT/OUTCOME: NAL Web sites continue to increase access to quality agricultural information. Several Web sites have received awards with high marks from professional organizations and the U.S. press for quality and importance.

investigate electronic mechanisms for improving the delivery of materials to patrons.

ACCOMPLISHMENTS: Identified two mechanisms to improve document delivery services: (1) RELAIS document system to support document delivery to USDA staff; and (2) Document paging system to make more efficient processing of document retrieval for customers in the Abraham Lincoln Building.

IMPACT/OUTCOME: Faster delivery of requested documents to clients and re-allocation of staff resources from document delivery to reference services, outreach and Web product development.

increase by thirty percent the total volume of services delivered to NAL customers.

ACCOMPLISHMENTS: The total volume of direct service transactions delivered to NAL customers grew to almost 23 million, an increase of 58 percent from FY 99, largely due to rapid growth in usage of NAL Web-based services.

IMPACT/OUTCOME: There was a dramatic increase in diffusion of information to NAL's global customer base.

PERFORMANCE GOAL 6.2.1.4: Develop an agricultural subject headings thesaurus.
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Indicators:

During FY 2000, NAL will

develop the top structures of the subject hierarchies and obtain input from expert reviewers in various subject areas.

ACCOMPLISHMENTS: The top structures and categories for the subject organization of all facets of agriculture were completed and the preliminary edition of the thesaurus is developing on schedule. Terms within most of the categories have been reviewed and revised. Feedback from subject experts was solicited from within and outside of USDA and their input helped expedite the development of the preliminary edition of the thesaurus.

IMPACT/OUTCOME: USDA agencies, such as ERS and ARS, and others needing a subject structure to organize and facilitate searching of their Web-based electronic documents, databases, and other Internet resources will have an authoritative thesaurus that is maintained by NAL. The first application of the thesaurus will be to index and organize the research projects in the ARIS system of the Agricultural Research Service.

contract with a thesaurus expert to assist in development, evaluation and testing of the thesaurus for use with the RMIS database.

ACCOMPLISHMENTS: A contract was negotiated with a recognized expert in thesauri for indexing scientific literature who will assist in suggesting terms, reviewing thesaurus principles, categories, and testing the thesaurus for indexing research reports.

IMPACT/OUTCOME: The contractor's experience and knowledge of other scientific vocabularies helps ensure that NAL's agricultural thesaurus will be as compatible as possible with other standard terminologies.

PERFORMANCE GOAL 6.2.1.5: Increase collaboration via AgNIC (Agriculture Network Information Center).

Indicators:

During FY 2000, NAL will

continue efforts to increase collaboration and partnerships within AgNIC through outreach and discussions between existing and potential partners.

ACCOMPLISHMENTS: The Agriculture Network Information Center (AgNIC) Alliance made substantial progress in expanding participation and increasing access to the information contributed by members, through its web site (<http://www.agnic.org>). More than 30 million accesses were delivered by AgNIC participant Web sites. The number of members increased to 36 covering more than 40 subjects. The AgNIC Coordinating Committee met in April 2000 at NAL with over 50 international participants. In August, the technical development team released version 2 of the Web site.

IMPACT/OUTCOME: The alliance increased global access to reliable agricultural information via the Web. The new version of the AgNIC interface provides improved searching and retrieval capabilities

for researchers.

PERFORMANCE GOAL 6.2.1.6: Develop programs and services for previously under-served audiences.

Indicators:

During FY 2000, NAL will

improve the utility of its web resources by instituting American Disabilities Act (ADA) guidelines.

ACCOMPLISHMENTS: The NAL's Web Management Team received training in ADA requirements and briefed the NAL staff on actions needed. Review of the upper two levels of the NAL web site was done with the Bobby evaluation program; needed modifications were made. The Federal ADA compliance deadline of August 2000 was postponed until sometime in 2001, so the NAL report will be filed at that time.

IMPACT/OUTCOME: NAL's awareness of and compliance with ADA guidelines will result in improved access to agricultural information for people with various disabilities.

develop partnerships and networks to reach minority, disabled, and other under-served customers.

ACCOMPLISHMENTS: The NAL continued to expand outreach to under-served groups by collaborating with land grant and other universities; library associations; and community groups on training programs; development of informational and instructional materials, including Web-based materials; and funding internships.

IMPACT/OUTCOME: Agricultural information was more available to previously under-served customers.

PERFORMANCE GOAL 6.2.1.7: Support increased diversity in librarianship and information management.

Indicators:

During FY 2000, NAL will

begin development of a diversity program plan.

ACCOMPLISHMENTS: The NAL completed a discussion version of its diversity program plan.

IMPACT/OUTCOME: The NAL is prepared to move forward with implementation of its diversity program plan in FY 2001.

continue to mentor minority librarians and information professionals through various professional association partnerships and other leadership and career development programs.

ACCOMPLISHMENTS: The Library Director and other staff members mentored minority students and young professionals.

IMPACT/OUTCOME: Minority librarians and information professionals' career development was

assisted by NAL's staff.

continue to participate in professional development seminars and programs for minority-serving institutions.

ACCOMPLISHMENTS: The NAL continued to participate in seminars and programs for the land grant universities and tribal colleges.

IMPACT/OUTCOME: More librarians of land grant universities and tribal colleges received direct training in agricultural information sources and systems.

continue to provide minority high school and college student internships that expose interns to library and information management career opportunities.

ACCOMPLISHMENTS: The NAL provided nine internships for minority high school and college students.

IMPACT/OUTCOME: The NAL continued to demonstrate the effectiveness of student internships in directing minority students towards careers in librarianship and agriculture.

STRATEGY 6.2.2: Strengthen National Agricultural Library Operations: Anticipate and provide information products and services, including educational programs, that enable NAL's diverse customers to identify, locate, and obtain desired information on agricultural topics.

PERFORMANCE GOAL 6.2.2.1: Expand acquisition of information in all formats.
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Indicators:

During FY 2000, NAL will

begin to systematically identify, acquire, and create links to electronic full text documents in the field of agricultural economics from the World Wide Web site called Research in Agricultural and Applied Economics, <http://agecon.lib.umn.edu/>, developed at the University of Minnesota with the cooperation and financial support of USDA's Economic Research Service and others.

ACCOMPLISHMENTS: The Public Services and Technical Services Divisions cooperated to establish routines to link from AGRICOLA to the "AgEcon" documents at the site of the University of Minnesota. The NAL's project to include these documents in AGRICOLA began in FY 2000 and is ongoing.

IMPACT/OUTCOME: Faster more effective access for NAL's global customers to agricultural literature was achieved via AGRICOLA.

select and increase links to relevant water quality resources identified by the Water Quality Information Center.

ACCOMPLISHMENTS: Approximately 170 titles of freely available, online documents covering water and agriculture were reviewed for inclusion into the AGRICOLA database. A prototype database of several hundred of these titles was made available to the public on the Water Quality Information Center Web site.

IMPACT/OUTCOME: People seeking online water quality information have improved means for

locating it.

PERFORMANCE GOAL 6.2.2.2: Gain space for collection growth.

Indicators:

During FY 2000, NAL will

continue to identify printed items in its collection that are on deteriorating newsprint which can be replaced by alternate formats.

ACCOMPLISHMENTS: In FY 2000, the team identified 60 titles on microfilm to be acquired from other sources.

IMPACT/OUTCOME: Replacing deteriorating newsprint with microfilm improved accessibility to the information because the newsprint in its existing form could not be used.

PERFORMANCE GOAL 6.2.2.3: Preserve and secure collections.

Indicators:

During FY 2000, NAL will

identify deteriorating collection materials to be boxed for preservation.

ACCOMPLISHMENTS: In FY 2000, the Document Delivery Service Branch identified 390 titles/volumes to be boxed for preservation, acquired the boxes, cleaned and inserted the volumes into the boxes and returned them to the shelves.

IMPACT/OUTCOME: These specially constructed boxes will house the fragile and deteriorating volumes to prevent further damage due to incidental impact or scrapes which would separate pages or covers from the original volume. They will also protect the fragile volumes from other conditions which cause deterioration such as dirt, light, and rapid changes in temperature and humidity.

strengthen security of the "cage" where special collections are housed.

ACCOMPLISHMENTS: The "cage" structure was evaluated and recommendations made for improving security.

IMPACT/OUTCOME: As funds become available, enhancements to the physical structure will provide increased security of collections.

PERFORMANCE GOAL 6.2.2.4: Increase number of records in the AGRICOLA database.

Indicators:

During FY 2000, NAL will increase the number of records in AGRICOLA by 74,000.

ACCOMPLISHMENTS: The NAL added over 74,700 indexing and cataloging records to the AGRICOLA database in FY 2000.

IMPACT/OUTCOME: More records of information resources important to agriculture were made available online to users of AGRICOLA.

PERFORMANCE GOAL 6.2.2.5: Increase linkages from the AGRICOLA database to electronic content.

Indicators:

During FY 2000, NAL will create new linkages for electronic versions of food safety research information reports, water quality and drought resources.

ACCOMPLISHMENTS: During FY 2000, NAL increased by 300 percent the number of citations directly linked to electronic content. There are now over 11,000 links to primary information from AGRICOLA indexing and cataloging records.

IMPACT/OUTCOME: AGRICOLA searchers have immediate access to the full text of an article, document or database described in over 11,000 database records. Increasing the speed of access to information contributes to reducing the potential for redundant research efforts.

PERFORMANCE GOAL 6.2.2.6: Continue modernization of the Abraham Lincoln Building.

Indicators:

During FY 2000, NAL will

continue to ensure the security surrounding special collections as appropriate. In addition, security of the building will be readdressed to assess and correct areas of vulnerability.

ACCOMPLISHMENTS: A security wall was built on the floor of the Abraham Lincoln Building that houses rare books. A security task force was initiated to develop a Library security plan and options.

IMPACT/OUTCOME: Better security in building.

procure Architectural and Engineering (A&E) services to redesign the 5th floor from office space to a "stack" and special collections floor.

ACCOMPLISHMENTS: A&E services were procured. The design should be completed in late spring 2001 with construction commencing in late summer.

IMPACT/OUTCOME: More space for collection.

PERFORMANCE GOAL 6.2.2.7: Ensure systematic upgrade of equipment.

Indicators:

During FY 2000, NAL will evaluate its computer base including desktops and servers to determine upgrade requirements to meet the rapidly growing electronic resource needs of NAL.

ACCOMPLISHMENTS: NAL's Web servers have been evaluated and recommendations made for replacement/upgrade. Recommendations will be acted on as resources become available. Evaluation

of workstations will be conducted in FY2001 in conjunction with the acquisition of a new electronic library management system.

IMPACT/OUTCOME:

PERFORMANCE GOAL 6.2.2.8: Ensure security of electronic data and computer equipment.

Indicators:

During FY 2000, NAL will contract for a thorough information system security assessment, implement a firewall and related security policies, and draft an NAL-wide information system security policy.

ACCOMPLISHMENTS: NAL contracted for a security assessment of its information systems to determine vulnerabilities and practices that need to be implemented to safeguard its network and data from the “hacker community”, human error, and white-collar crime. As a result of this assessment, a firewall was installed in 2000 to protect NAL’s private network as well as to support the establishment of separate security zones for the Electronic Services Center and NAL’s production network. The information system security policy is still being developed.

IMPACT/OUTCOME: NAL has significantly increased its security profile so that vital data and services are less likely to be disrupted by unauthorized actions.

PERFORMANCE GOAL 6.2.2.9: Implement new electronic library management system with minimal disruption to customers and staff/operations.

Indicators:

During FY 2000, NAL will

begin efforts to identify and acquire a new electronic library management system, develop system and functional requirements for the new system, identify candidate electronic library management systems and make vendor contracts to arrange demonstrations, and identify hardware platform and database system that will support a new electronic library management system.

ACCOMPLISHMENTS: In FY 2000, NAL completed the documentation of functional and system requirements for a new electronic library management system and identified five systems for demonstration and investigation. After vendor demonstrations, the Library identified three potential systems and obtained preliminary cost estimates from their vendors.

IMPACT/OUTCOME: The NAL is ready to proceed on a procurement plan to purchase a new electronic system as soon as funding is available. A new system will increase the efficiency of internal operations, provide more management data to inform decisions on operations, and provide new and powerful Web gateway tools to users accessing the library’s resources via the Internet.

PERFORMANCE GOAL 6.2.2.10: Refine administrative and business processes, organizational structures, and functions.

Indicators:

During FY 2000, NAL will continue to seek opportunities to streamline administrative processes.

ACCOMPLISHMENTS: As opportunities arose, administrative personnel reviewed processes and streamlined them where possible.

IMPACT/OUTCOME: More efficient and effective internal administration.

PERFORMANCE GOAL 6.2.2.11: Develop Intranet.

Indicators:

During FY 2000, NAL's Web Management Team will make a preliminary assessment of NAL's internal electronic communication needs.

ACCOMPLISHMENTS: NAL began an assessment of developing an Intranet to improve internal communications.

IMPACT/OUTCOME: An Intranet will be developed beginning in FY 2001.

PERFORMANCE GOAL 6.2.2.12: Ensure equitable opportunities for staff development.

Indicators:

During FY 2000, NAL will ensure that each staff member receives adequate training to support his or her function. Staff members will also be given career enhancement opportunities such as details, shadowing assignments, and agency leadership development programs.

ACCOMPLISHMENTS: Supervisory training was scheduled for supervisors. Other employees participated in details and shadowing assignments outside of NAL. Others participated in agency sponsored programs and activities.

IMPACT/OUTCOME: Personnel gained a broader perspective of agency/governmental activities and brought back new knowledge/skills to their job as well as enhanced career opportunities.

PERFORMANCE GOAL 6.2.2.13: Implement staff succession plan.

Indicators:

During FY 2000, NAL will provide opportunities for employees to gain leadership experience through acting, detail, and shadowing assignments as well as attending management meetings whenever possible.

ACCOMPLISHMENTS: Various staff members participated in career development assignments.

IMPACT/OUTCOME: More of the Library staff was offered opportunities for internal career development.

OBJECTIVE 6.3: Creative leadership: "Promote excellence, relevance, and recognition of agricultural research through creative leadership in management and development of resources, communications systems, and partnerships with our customers and stakeholders."

STRATEGY 6.3.1: Develop research agenda: Identify ARS program priorities and core research

capabilities and use them to provide leadership in developing national research agendas.

PERFORMANCE GOAL 6.3.1.1: Annual conferences of public and private individuals are convened to discuss major researchable issues in agriculture and articulate approaches to addressing these problems.

Indicators:

During FY 2000, ARS will convene a number of programmatic workshops and conferences to help shape the ARS research agenda.

ACCOMPLISHMENTS: In FY 2000, ARS convened 17 National Program Workshops or National Program Component Workshops covering all or part of National Programs 101, Food Animal Production; 102, Animal Health; 107, Human Nutrition; 203, Air Quality; 204, Global Change; 207, Integrated Agricultural Systems; 301, Plant, Microbial and Insect Genetic Resources, Genomics, and Genetic Improvement; 303, Plant Diseases; 304, Crop Protection and Quarantine; 306, New Uses, Quality, and Marketability of Plant and Animal Products; and 308, Methyl Bromide Alternatives.

IMPACT/OUTCOME: Customer input and interaction with ARS scientists helped to develop the research agenda for each National Program.

STRATEGY 6.3.2: Civil rights: The ARS Civil Rights Staff (CRS) recognizes that systematic communication is important as a means of ensuring that its services meet the expectations and needs of its customers and stakeholders, including managers, supervisors, and employees.

PERFORMANCE GOAL 6.3.2.1: Recommendations are implemented and processes and practices are modified as appropriate.

Indicators:

During FY 2000, ARS will establish monthly meetings with Area Civil Rights Managers (ACRMs) to keep communication lines open.

ACCOMPLISHMENTS: ARS scheduled monthly meetings with the ACRMs during FY 2000 to keep communication lines open and will continue this practice in subsequent years.

IMPACT/OUTCOME: The ACRMs are kept current on ARS EEO/CR issues.

PERFORMANCE GOAL 6.3.2.2: ARS managers, supervisors, and employees are better informed on EEO/CR issues.

Indicators:

During FY 2000, ARS will publish brochures and create an EEO/CR web page.

ACCOMPLISHMENTS: ARS developed a draft brochure on the ARS Civil Rights Programs. It also developed the EEO/CR web page and placed it online.

IMPACT/OUTCOME: ARS managers, supervisors, and employees are now better informed on EEO/CR issues.

PERFORMANCE GOAL 6.3.2.3: Recommendations resulting from the agencywide on-site EEO compliance review are implemented.

Indicators:

During FY 2000, ARS will conduct an agencywide compliance review which will result in recommendations for improvements in the agency's EEO program.

ACCOMPLISHMENTS: ARS conducted the agencywide EEO compliance review of headquarters and area offices during April - September 2000. A number of randomly selected location offices was also reviewed.

IMPACT/OUTCOME: A draft report will be prepared which will contain a summary of the information obtained, specific findings of fact, specific noncompliance issues, and recommendations for improvement to correct any noncompliance or other EEO problems will be prepared.

PERFORMANCE GOAL 6.3.2.4: A comprehensive, fully integrated system is installed to assist in analyzing workforce profiles, analyzing adverse impacts, and monitoring every aspect of discrimination complaint processing.

Indicators:

During FY 2000, ARS will purchase the EEO Assistant Database software and the Civil Rights Staff will be trained to use the software.

ACCOMPLISHMENTS: The EEO Assistant Database software was purchased and CRS employees received training in the use of the software during September 2000.

IMPACT/OUTCOME: Employees can retrieve and analyze complaint and workforce data and carry out day-to-day responsibilities in a more efficient manner.

STRATEGY 6.3.3: Management of facilities: Provide appropriately equipped Federal facilities required to support the research and information activities of ARS into the next century.

PERFORMANCE GOAL 6.3.3.1: Criteria and priorities are identified.

Indicators:

During FY 2000, ARS will update its facilities modernization plan which identifies ongoing repair and maintenance needs of existing agency laboratory and support facilities.

ACCOMPLISHMENTS: In FY 2000, ARS updated the 10 Year Facilities Plan which identified future projects or needs in terms of repair and maintenance/modernization, new construction, energy retrofit, accessibility, hazardous waste clean up, and building disposal/demolition needs from FY 2001 to 2010.

IMPACT/OUTCOME: Implemented priority construction, modernization, and repair and maintenance needs to support the research mission of the Agency. With these improved facilities, ARS scientists will have available state-of-the-art facilities to conduct research. In addition, the employee work

environment will meet all safety and health requirements, as well as meet the President's energy conservation goals.

PERFORMANCE GOAL 6.3.3.2: Priority projects are proposed for funding in ARS annual building and facility request.

Indicators:

During FY 2000, ARS will identify facilities to be modernized and constructed in accordance with mission priorities. The facility information will be forwarded to the Department for B & F (building and facility) funding consideration.

ACCOMPLISHMENTS: In FY 2000, ARS forwarded to the Department a request for \$135,845,000 in new B & F funding to address facility needs. Of this amount Congress eventually appropriated \$52,500,000 new construction and facilities modernization at priority locations.

IMPACT/OUTCOME: Implemented priority construction, modernization, and repair and maintenance needs to support the research mission of the Agency. With these improved facilities, ARS scientists will have available state-of-the-art facilities to conduct research. In addition, the employee work environment will meet all safety and health requirements, as well as meet the President's energy conservation goals.

STRATEGY 6.3.4: Maintenance of core research capabilities: Develop and implement comprehensive human resource systems and other administrative and financial support systems and policies to support and enhance ARS' core research capabilities while maintaining the flexibility to shift research and form interdisciplinary teams to address emerging problems.

PERFORMANCE GOAL 6.3.4.1: Identify core capability requirements and develop a scientific staff to meet long-term research needs.

Indicators:

During FY 2000, ARS will

increase its core capability by significantly increasing the number of research scientist positions (SYs).

ACCOMPLISHMENTS: ARS began FY 2000 with 1919 SYs on the rolls. By the end of FY 2000, it increased the number to 1963 on-board and 39 SYs pending entry on duty. This totaled 2002 SYs which slightly exceeded the core capability goal set by the Administrator. This goal was reached despite the fact that 103 SYs resigned, retired, or otherwise left the Agency during the fiscal year.

IMPACT/OUTCOME: ARS has a much stronger and higher quality research capability and is able to better respond to the many rapidly emerging agricultural problems facing the U.S. and the world.

conduct three consolidated scientist recruitment cycles.

ACCOMPLISHMENTS: Three cycles were conducted: Fall, Spring, and Summer. Consolidated recruitment included use of paid ads and the Internet for advertising, and publicizing vacancies at major professional society meetings. An average of 10 applications was received for each vacancy.

IMPACT/OUTCOME: Conducting the three cycles contributed to the success of the Accomplishment listed above, that is, restoration of core research capability in the Agency. The ad campaigns and use of Internet advertising resulted in broader distribution of information about ARS SY vacancies and a higher number of applications being received.

develop a core curriculum for new scientist orientation for use at field offices and laboratories.

ACCOMPLISHMENTS: The framework of a core curriculum has been developed, and has been used by all of the 8 Area Offices for conducting New SY orientation in FY 2000. The final version of the framework will be published by March 30, 2001.

IMPACT/OUTCOME: Newly hired SYs have become familiar with the Agency culture more quickly, have been provided with Agency information on reporting research and program accountability, and have received practical information on how to get things done (e.g. purchase equipment, hire technician support).

implement a new research leader training program. A formal leadership training program will also be established, including orientation within Headquarters and the Areas.

ACCOMPLISHMENTS: The New RL Training Program was established in FY 2000. There are 35 new RL participants in the Class of 2000. The first HQ orientation was conducted in April 2000. Participants who had not previously been enrolled in the Leadership Laboratory or attended the Congressional Briefings participated in the two offerings. IDP's have been developed for each new RL, tailored toward the type of training they specifically need. Registration for the Class of 2001 is now open.

IMPACT/OUTCOME: New RL's learned leadership skills, making them better leaders and supervisors. They gained exposure to Agency requirements and expectations during the HQ Orientation, and gained an understanding of how Congress works and an overview of the budget process during the Congressional Briefings.

PERFORMANCE GOAL 6.3.4.2: Train postdoctoral students through the ARS Research Associate Program and competitively select 10 percent each year to fill full-time positions.
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Indicators:

During FY 2000, ARS will maintain its Research Associate Program as a source of qualified candidates for permanent research positions.

ACCOMPLISHMENTS: In FY 2000, ARS had 365 Research Associates on the rolls.

IMPACT/OUTCOME: Thirty-nine of the ARS Research Associates competed successfully and were selected for permanent Research Scientist positions in FY 2001.

STRATEGY 6.3.5: Provide administrative support to REE: Serve as the lead agency in providing administrative and financial management services for Research, Education, and Economics (REE) headquarters and field locations.

PERFORMANCE GOAL 6.3.5.1: Customer and employee participation in planning processes.

Indicators:

During FY 2000, ARS will continue to monitor customer and employee needs consistent with the AFM Strategic Plan and develop an AFM-wide customer and employee survey to obtain feedback on customer and employee satisfaction.

ACCOMPLISHMENTS: Each AFM functional division conducted a written survey of customers. Results were analyzed and action plans to address issues were developed, posted on the Division Web site, and implemented.

Teams were created to address issues raised during the biennial employee climate survey. Team recommendations were adopted regarding awards system, internal communications, employee involvement in the AFM Strategic Plan, and supervisor training.

IMPACT/OUTCOME: Customer service has been streamlined, errors reduced, and customer satisfaction increased. The employee awards system is more equitable and employee morale is improved. Communication, particularly between supervisors and employees has improved.

PERFORMANCE GOAL 6.3.5.2: Strategic plan is developed and communicated to REE customers and employees.

Indicators:

During FY 2000, ARS will collect customer and employee feedback to identify changing priorities and begin refinement of its Strategic Plan.

ACCOMPLISHMENTS: Each functional area of AFM conducted extensive customer surveys. Employee and customer feedback was also collected through focus groups, all-hands meetings, employee surveys, and face-to-face meetings with key personnel. A study of customer satisfaction was conducted by a private contractor and opportunities for improvement were identified.

An executive review team was established to study the AFM strategic planning process.

IMPACT/OUTCOME: A new version of the AFM Strategic Plan is under development. The new version will include reworked objectives on customer and employee feedback.

An action plan with target dates to address the opportunities identified in the external review report was developed and sent to all agency administrators.

PERFORMANCE GOAL 6.3.5.3: Formal feedback is solicited from REE customers.

Indicators:

During FY 2000, ARS will conduct written customer service surveys, meet regularly with REE agency administrators, conduct customer focus group sessions, and solicit customer feedback through the AFM web site.

ACCOMPLISHMENTS: AFM conducts regular, written customer surveys (see Goal 6.3.5.1 above).

Meetings with Agency administrators are held weekly. Various AFM sections and branches conduct regular focus group sessions with REE customers. Each AFM division Web site, and the AFM main page solicits customer feedback. Responses to comments and questions are prompt and accurate.

IMPACT/OUTCOME: Areas of customer concern and interest have been quickly identified and addressed. AFM service is more efficient. Customer communication is good and customer satisfaction with AFM is high.

STRATEGY 6.3.6: Program Excellence and Relevance: Ensure excellence and relevance to ARS National Programs through peer reviews of research projects.

PERFORMANCE GOAL 6.3.6.1: Panel peer reviews are conducted on all research projects before implementation and subsequently every five years. The majority of the peer reviewers are external to ARS.

Indicators:

During FY 2000, ARS will panel peer review approximately 75 research projects.

ACCOMPLISHMENTS: 152 projects were panel reviewed in FY 2000.

IMPACT/OUTCOME: ARS met its goal to implement the new Peer Review Process with several pilot review sessions. Each project plan benefitted from its review and, in most cases, was certified for implementation within 3 months of the panel review.

PERFORMANCE GOAL 6.3.6.2: Review of the productivity, quality, and impact of individual scientists is conducted as scheduled in the Research Position Evaluation System (RPES).

Indicators:

During FY 2000, ARS will conduct RPES reviews of approximately 350 agency scientists.

ACCOMPLISHMENTS: During FY 2000, RPES peer panels reviewed a total of 356 ARS research scientist positions.

IMPACT/OUTCOME: Results of the reviews are:

	Upgrade - 163 (45.8%)
(52.0%)	Remain in Grade - 185

STRATEGY 6.3.7: Improve financial management: ARS/Administrative and Financial Management will support Departmental efforts to improve financial management.

PERFORMANCE GOAL 6.3.7.1: Implement integrated management systems in USDA.

Indicators:

Reporting will begin upon issuance of Departmental evidence on the Foundation of Financial Information System (FFIS) for mandatory use by USDA agencies.

During FY 2000, ARS will

continue to work with the Office of the Chief Financial Officer (OCFO) on the design and modification of the FFIS for use by REE.

ACCOMPLISHMENTS: Initiated FFIS implementation work groups for each REE agency.

IMPACT/OUTCOME: Implementation is underway.

continue to work with the NFC on implementing new and modernized financial systems for the REE agencies.

ACCOMPLISHMENTS: Initiated FFIS implementation work groups for each REE agency.

IMPACT/OUTCOME: Implementation is underway.

PERFORMANCE GOAL 6.3.7.2: Correct in a timely manner internal control deficiencies.
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Indicators:

Reporting will begin upon issuance of Departmental evidence on the FFIS for mandatory use by USDA agencies.

During FY 2000, ARS will continue compliance with the FMFIA, including the timely completion of audit report recommendations and the timely correction of any FMFIA weaknesses that are identified.

ACCOMPLISHMENTS: Reviewed all GAO, OIG, and external audit recommendations and implemented corrective action as necessary.

IMPACT/OUTCOME: All identified FMFIA weaknesses are corrected.

PERFORMANCE GOAL 6.3.7.3: Clean and timely opinions are provided on audited financial statements.
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Indicators:

Reporting will begin upon issuance of Departmental evidence on the FFIS for mandatory use by USDA agencies.

During FY 2000, ARS will prepare, review, and certify the yearly consolidated financial statements of the REE agencies as required under the Chief Financial Officer's Act.

ACCOMPLISHMENTS: Auditable financial statements were prepared in accordance with approved Departmental accounting standards.

IMPACT/OUTCOME: Financial statements are prepared correctly and receive a favorable auditor's opinion.

STRATEGY 6.3.8: Outreach: ARS will bring the benefits of research to under-served populations, identify barriers that prevent under-served populations from receiving and using agency-generated knowledge/technology, and increase participation of under-represented groups in agency procurement contracts.

PERFORMANCE GOAL 6.3.8.1: ARS will identify and generate a comprehensive directory of organizations that serve the under-served who are potential users of ARS research.

Indicators:

During FY 2000, ARS will identify research contacts in organizations serving historically under-served producers.

ACCOMPLISHMENTS: As of October 31, 2000, a directory of approximately 100+ outreach research contacts has been created.

IMPACT/OUTCOME: This database will enable ARS to involve representatives of historically under-served producers in research planning and technology transfer activities.

PERFORMANCE GOAL 6.3.8.2: ARS will convene a national outreach workshop that will bring together representatives of under-served populations.

Reporting will begin on this Performance Goal in FY 2001.

PERFORMANCE GOAL 6.3.8.3: In FY 2001, each ARS Area will convene Area workshops to identify researchable issues of interest to under-served populations

Indicators:

Reporting will begin on this Performance Goal in FY 2001.

PERFORMANCE GOAL 6.3.8.4: In FY 2000 (using 1999 data), establish baseline data for extramural agreements, Memoranda of Understanding, and Letters of Agreement with organizations serving historically under-served populations.

Indicators:

During FY 2000, ARS will establish baseline data for extramural agreement awards to organizations serving historically under-served populations.

ACCOMPLISHMENTS: The FY 1999 baseline data is 17 total awards to historically under-served organizations (1890's) for a total of \$1.6 million, which represents approximately 1.6% of total FY 1999 extramural funding of over \$105 million.

IMPACT/OUTCOME: N/A

PERFORMANCE GOAL 6.3.8.5: In FY 2001, ARS will increase its extramural agreements to organizations which serve under-served populations by no less than 20 percent over its established (FY 1999) baseline.

Indicators:

Reporting will begin on this Performance Goal in FY 2001.

PERFORMANCE GOAL 6.3.8.6: In FY 2001, ARS will show an increase in the number of invitations extended to representatives of under-served populations to participate in program workshops, symposia, project/program reviews, and site/location reviews.

Indicators:

Reporting will begin on this Performance Goal in FY 2001.

PERFORMANCE GOAL 6.3.8.7: In FY 2001, ARS will show an increase in the number of research collaborations and technology transfer activities focused on meeting the special needs of this target population.

Indicators:

Reporting will begin on this Performance Goal in FY 2001.

PERFORMANCE GOAL 6.3.8.8: In FY 2000, ARS will inform all senior managers and SYs of their roles and responsibilities under the outreach plan.

Indicators:

During FY 2000, *ARS will brief senior agency managers.*

ACCOMPLISHMENTS: The Administrator's Council (comprised of the Agency's senior managers) was briefed on their roles and responsibilities under the ARS Outreach Plan during their September 12-14, 2000, meeting. Further activities directed to all scientists and other managers will occur throughout FY 2001.

IMPACT/OUTCOME: The briefing for senior ARS managers enhanced support for the Department's outreach initiatives.

PERFORMANCE GOAL 6.3.8.9: In FY 2001, ARS will expand access to research information by the historically under-served organizations.

Indicators:

Reporting will begin on this Performance Goal in FY 2001.

PERFORMANCE GOAL 6.3.8.10: ARS will expand outreach efforts to interest under-served students in agriculture/food science.

Indicators:

Reporting will begin on this Performance Goal in FY 2001.

PERFORMANCE GOAL 6.3.8.11: ARS will work with educational institutions and community-based organizations serving target populations to identify barriers and develop strategies to get information to under-served populations.

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Indicators:

Reporting will begin on this Performance Goal in FY 2001.